# LDCC COOLING TOWER IMPROVEMENTS

Los Alamos National Laboratory
Los Alamos, New Mexico

Rev. 0, September 9, 2002

## Construction Specifications

Project Identification No. 100256

Unclassified

# LDCC COOLING TOWER IMPROVEMENTS

## LOS ALAMOS NATIONAL LABORATORY

**UNIVERSITY OF CALIFORNIA**

**LOS ALAMOS, NEW MEXICO**

**Rev. 0**
**September 9, 2002**

**PREPARED BY:**

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**LOS ALAMOS, NEW MEXICO 87544**

Jim Edwards

SUBMITTED: Jim Edwards, HNR

APPROVED:

Unclassified

CLASSIFICATION

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REVIEWER:

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Holmes & Narver | Raytheon

## PROFESSIONAL APPROVAL FORM

Project/Task Title: **LDCC COOLING TOWER IMPROVEMENTS** Subcontract No. _135681102CX____
Project ID/Task No. 100256/TASK 83 Specification(s) No C3442.083.001____
Rev. 0 Issue Date: September 09, 2002_____

**SPECIFICATIONS**
FOR
PROFESSIONAL APPROVAL

The designs, specifications, and drawings comprising this subcontract have been prepared by or under the cognizance of Registered Engineers holding a valid license in the State of New Mexico issued by the State Board of Registration for Professional Engineers, and Licensed Architects holding valid licenses in the State of New Mexico issued by the Board of Architectural Examiners.

**DISCIPLINE STRUCTURAL**

| | |
|---|---|
| David A. Apple — Designer | 8-29-02 — Date |
| Checker | 8.29.02 — Date |
| Discipline Lead | 8.29.02 — Date |

**DISCIPLINE MECHANICAL**

| | |
|---|---|
| Michael Stamen — Designer | 9/9/02 — Date |
| Checker | 9/9/02 — Date |
| Discipline Lead | 9/9/02 — Date |

**DISCIPLINE ELECTRICAL**

| | |
|---|---|
| Charles J. Thompson — Designer | 9/9/02 — Date |
| William P. Herbst — Checker | 8/28/02 — Date |
| William P. Herbst — Discipline Lead | 8/28/02 — Date |

| STRUCTURAL | MECHANICAL | ELECTRICAL |
|---|---|---|
| DAVID A. APPLE NEW MEXICO 14908 REGISTERED PROFESSIONAL ENGINEER | JOHN B. GRAPSAS NEW MEXICO 10214 REGISTERED PROFESSIONAL ENGINEER | WILLIAM P. HERBST STATE OF No. 10695 NEW MEXICO REGISTERED PROFESSIONAL ENGINEER |
| 8-29-02 | 9-9-02 | 8/28/02 |

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## DIVISION 10 – SPECIALTIES

Not Used

## DIVISION 11 – EQUIPMENT

Not Used

## DIVISION 12 – FURNISHINGS

Not Used

## DIVISION 13 – SPECIAL CONSTRUCTION

Not Used

## DIVISION 14 – CONVEYING SYSTEMS

Not Used

## DIVISION 15 – MECHANICAL



## DIVISION 16 – ELECTRICAL

SECTION 01090

REFERENCE STANDARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance

B. Schedule of references

1.2 QUALITY ASSURANCE

A. Conform to reference standard by date of issue current on date for receiving bids.

B. Should specified reference standards conflict with Contract Documents, request clarification from Contract Administrator before proceeding.

1.3 SCHEDULE OF REFERENCES

To the extent specified elsewhere in these Contract Documents, comply with the requirements of the following standards and associations.

AA Aluminum Association
900 19th Street, N.W., Suite 300
Washington, DC 20006
(202) 862-5100

AABC Associated Air Balance Council
1518 K Street, N.W.
Washington, DC 20005
(202) 737-0202

AAMA American Architectural Manufacturers Association
1540 E. Dundee Road, Suite 310
Palatine, IL 60067
(708) 202-1350

AASHTO American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W., Suite 249
Washington, DC 20001
(202) 624-5800

ABMA American Boiler Manufacturers Association
950 N. Glebe Road, Suite 160
Arlington, VA 22203
(703) 522-7350

ACI American Concrete Institute
Box 19150
Detroit, MI 48219
(313) 532-2600

ADC Air Diffusion Council
111 E. Wacker Drive
Chicago, IL 60601-4298
(312) 616-0800

AEIC Association of Edison Illuminating Companies
600 N. 18th Street
P.O. Box 2641
Birmingham, AL 35291-0992
(205) 250-2530

AGA American Gas Association
1515 Wilson Blvd.
Arlington, VA 22029
(703) 841-8400.

AGC Associated General Contractors of America
1957 E. Street, N.W.
Washington, DC 20006
(202) 393-2040

AI Asphalt Institute
Research Park Drive
P.O. Box 14052
Lexington, KY 40512-4052
(606) 288-4960

AIA American Institute of Architects
1735 New York Avenue, N.W.
Washington, DC 20006
(202) 626-7300

AISC American Institute of Steel Construction
One East Wacker Drive, Suite 1300
Chicago, IL 60601-2001
(312) 670-2400

AISI American Iron and Steel Institute
1101 17th Street, N.W.
Washington, DC 20036-4700
(202) 452-7100

AITC American Institute of Timber Construction
11818 S.E. Mill Plain Blvd., Suite 407
Vancover, WA 98684-5092
(206) 254-9132

ALSC American Lumber Standards Committee
P.O. Box 210
Germantown, MD 20875
(301) 972-1700

AMCA Air Movement and Control Association
30 West University Drive
Arlington Heights, IL 60004-1893
(708) 394-0150

ANSI American National Standards Institute
11 West 42nd Street
New York, NY 10036
(212) 642-4900

APA American Plywood Association
Box 11700
Tacoma, WA 98411
(206) 565-6600

API American Petroleum Institute
1200 L Street, N.W.
Washington, DC 20005
(202) 682-8000

ARI Air-Conditioning and Refrigeration Institute
4301 N. Fairfax Drive, No. 425
Arlington, VA 22203
(703) 524-8800

ASA Acoustical Society of America
500 Sunnyside Boulevard
Woodbury, NY 11797
(516) 349-7800

ASCE American Society of Civil Engineers
1015 15th Street, N.W., Suite 600
Washington, DC 20005
(212) 705-7496

ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, GA 30329
(404) 636-8400

ASME American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017
(212) 705-7722

ASPA American Sod Producers Association
1855-A Hicks Road
Rolling Meadows, IL 60008
(708) 705-9898

ASTM American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103-1187
(215) 299-5400

AWI Architectural Woodwork Institute
P.O. Box 1550
13924 Broaddock Road, Suite 100
Centreville, VA 22020
(703) 222-1100

AWPA American Wood-Preservers' Association
P.O. Box 286
Woodstock, MD 21163-0286
(410) 465-3169

AWS American Welding Society
550 LeJeune Road, N.W.
P.O. Box 35140
Miami, FL 33135
(305) 443-9353

AWWA American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235
(303) 794-7711

BHMA Builders Hardware Manufacturers Association
355 Lexington Avenue
New York, NY 10017
(212) 661-4261

BIA Brick Institute of America
11490 Commerce Park Drive
Reston, VA 22091
(703) 620-0010

BOCA Building Officials & Code Administrators International, Inc.
4051 W. Flossmoor Road
Country Club Hills, IL 60478-5795
(708) 799-2300

CBM Certified Ballast Manufacturers Association
1422 Euclid Avenue, No. 402
Cleveland, OH 44115
(216) 241-0711

CDA Copper Development Association
260 Madison Avenue
New York, NY 10016
(203) 625-8210

CGA Compressed Gas Association
1725 Jefferson Davis Hwy., Suite 1004
Arlington, VA 22202-4100
(703) 412-0900

CISPI Cast Iron Soil Pipe Institute
5959 Shallowford Road, Suite 419
Chattanooga, TN 37421
(615) 892-0137

CLFMI Chain Link Fence Manufacturers Institute
1776 Massachusetts Avenue, N.W., No. 500
Washington, DC 20036
(202) 659-3537

CMAA Crane Manufacturers Association of America
8720 Red Oak Blvd., Suite 201
Charlotte, NC 28217
(704) 522-8644

CRSI Concrete Reinforcing Steel Institute
933 Plum Grove Road
Schaumburg, IL 60173
(708) 517-1200

CSI Construction Specifications Institute
60l Madison Street
Alexandria, VA 223l4-1791
(703) 684-0300

CTI Cooling Tower Institute
P.O. Box 73383
Houston, TX 77273
(713) 583-4087

DHI Door and Hardware Institute
14170 Newbrook Drive
Chantilly, VA 22022-2223
(703) 222-2010

EJMA Expansion Joint Manufacturers Association
25 North Broadway
Tarrytown, NY 10591
(914) 332-0040

ETL Environmental Testing Laboratories
P.O. Box 2040, Route 11, Industrial Park
Cortland, NY 13045
(607) 753-6711

FGMA Flat Glass Marketing Association
White Lakes Professional Building
3310 S.W. Harrison
Topeka, KS 66611-2279
(913) 266-7013

FM Factory Mutual System
FM Approval Guide
1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, MA 02062
(617) 762-4300

FS Federal Specification
Naval Publications Forms Center
5801 Tabor Avenue
Philadelphia, PA 19120
(215) 697-2000

GA Gypsum Association
810 First Street, N.E., Suite 510
Washington, DC 20002
(202) 289-5440

ICBO International Conference of
Building Officials
5360 S. Workman Mill Road
Whittier, CA 90601
(310) 699-0541

ICEA Insulated Cable Engineers Association, Inc.
P.O. Box 440
South Yarmouth, MA 02664
(508) 394-4424

IEEE Institute of Electrical and Electronics
Engineers
345 East 47th Street
New York, NY 10017
(212) 705-7900

IES Illumination Engineers Society of North America
120 Wall Street
New York, NY 10005
(212) 248-5000

IMI International Masonry Institute
823 15th Street, N.W.
Washington, DC 20005
(202) 783-3908

IPCEA Insulated Power Cable Engineers Association
P.O. Box 440
South Yarmouth, MA 02664
(508) 394-4424

IRI Industrial Risk Insurers
85 Woodland Street
Hartford, CT 06102
(203) 520-7300

ISA Instrument Society of America
P.O. Box 12277
67 Alexandria Drive
Research Triangle Park, NC 27709
(919) 549-8411

LPI Lightning Protection Institute
3365 North Arlington Heights Road, Suite J
Arlington Heights, IL 60004
(800) 488-6864

MBMA Metal Building Manufacturers Association
1300 Summer Avenue
Cleveland, OH 44115-2851
(216) 241-7333

MFMA Maple Flooring Manufacturers Association
60 Rivere Drive, Suite 500
Northbrook, IL 60062
(708) 480-9138

MIL Military Specifications
Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, PA 19120
(215) 697-2000

MMA Monorail Manufacturers Association
8720 Red Oak Boulevard, Suite 201
Charlotte, NC 28217
(704) 522-8644

MS Military Standard Drawings
Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, PA 19120
(215) 697-2000

MSS Manufacturers Standardization Society of the Valve and Fitting Industry
127 Park Street, N.E.
Vienna, VA 22180
(703) 281-6613

NAAMM National Association of Architectural Metal Manufacturers
600 S. Federal Street
Chicago, IL 60605
(312) 922-6222

NBBP National Board of Boiler & Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, OH 43229
(614) 888-8320

NCMA National Concrete Masonry Association
2302 Horse Pen Road
Herndon, VA 22071-3406
(703) 713-1900

NEBB National Environmental Balancing Bureau
1385 Piccard Drive
Rockville, MD 20850
(301) 977-3698

NEC National Electric Code (NFPA-70)
One Batterymarch Park
P.O. Box 1901
Quincy, MA 02269
(617) 770-3000; (800) 344-3555

NECA National Electrical Contractors Association
3 Bethesda, Metro Center, Suite 1100
Bethesda, MD 20814
(301) 657-3110

NEMA National Electrical Manufacturers' Association
2101 L Street, N.W.
Washington, DC 20037
(202) 457-8400

NETA International Electrical Testing Association
P.O. Box 687
Morrison, CO 80465
(303) 467-0520

NFPA National Fire Protection Association
National Fire Codes
One Batterymarch Park
P. O. Box l90l
Quincy, MA 02269-9101
(617) 770-3000; (800) 344-3555

NIST National Institute of Standards and Technology Standards, Codes, Programs and Information
Room A629, Building 101
Gaithersburg, MD 20899-0001
(301) 975-4029

NMSHD New Mexico State Highway Department
1120 Cerrillos Road
Santa Fe, NM 87503
(505) 827-5100

NSWMA National Solid Wastes Management Association
1730 Rhode Island Avenue, N.W., Suite 1000
Washington, DC 20036
(202) 659-4613

NTMA National Terrazzo and Mosaic Association
3166 Des Plaines Avenue, Suite 132
Des Plaines, IL 60018
(708) 635-7744

NWWDA National Wood Window and Door Association
1400 E. Touhy Avenue, No. G54
Des Plaines, IL 60018
(708) 299-5200

OSHA Occupational Safety and Health Administration
U.S. Department of Labor
Publications
200 Constitution Avenue, N.W.
Washington, DC 20210
(202) 219-4667

PCA Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077
(708) 966-6200

PCI Precast/Prestressed Concrete Institute
175 West Jackson Boulevard
Chicago, IL 60604
(312) 786-0300

PDI Plumbing and Drainage Institute
c/o Sol Baker
1106 W. 77th Street, South Drive
Indianapolis, IN 46260
(317) 251-6970

PS Product Standard
U. S. Department of Commerce
Standards and Codes Information
Room A163, Building 411
Gaithersburg, MD 20899
(301)) 975-2000

SAMA Scientific Apparatus Makers Association
225 Reinekers, Suite 625
Alexandria, VA 23314
(703) 836-1360

SDI Steel Deck Institute
P.O. Box 9506
Canton, OH 44711
(216) 493-7886

SDI Steel Door Institute
30200 Detroit Road
Cleveland, OH 44145
(216) 899-0010

SIGMA Sealed Insulating Glass Manufacturers Association
401 N. Michigan
Chicago, IL 60611
(312) 644-6610

SJI Steel Joist Institute
1205 48th Avenue North
Suite A
Myrtle Beach, SC 29577
(803) 449-0487

SMACNA Sheet Metal and Air Conditioning Contractors' National Association
4210 Lafayette Center Drive
Chantilly, VA 22021
(703) 803-2980

SPIB Southern Pine Inspection Bureau
4709 Scenic Highway
Pensacola, FL 32504
(904) 434-2611

SPRI Single Ply Roofing Institute
20 Walnut Street
Wellesley Hills, MA 02189
(617) 237-7879

SSPC Steel Structures Painting Council
4400 Fifth Avenue
Pittsburgh, PA 15213-2683
(412) 268-3327

STI Steel Tank Institute
570 Oakwood Road
Lake Zurich, IL 60047
(708) 428-8265

TCA Tile Council of America, Inc.
P.O. Box 326
Princeton, NJ 08540-0326
(609) 921-7050

TEMA Tubular Exchanger Manufacturers Association
25 N. Broadway
Tarrytown, NY 10591
(914) 332-0040

UBC Uniform Building Code
International Conference of Building Officials
5360 South Workman Mill Road
Whittier, CA 90601
(310) 699-0541

UL Underwriters' Laboratories, Inc.
UL Directories
333 Pfingston Road
Northbrook, IL 60062
(708) 272-8800

UMC Uniform Mechanical Code
International Association of Plumbing and Mechanical Officials
20001 South Walnut Drive
Walnut, CA 91789
(909) 595-8449

UPC Uniform Plumbing Code
International Association of Plumbing and Mechanical Officials
20001 South Walnut Drive
Walnut, CA 91789
(909) 595-8449

WCLIB West Coast Lumber Inspection Bureau
Box 23145
Portland, OR 97281
(503) 639-0651

WWPA Western Wood Products Association
Yeon Building
522 SW 5th Avenue
Portland, OR 97204-2122
(503) 224-3930

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Transmittal of submittals

B. Submittal procedures

C. Definition of submittal types for construction

D. Submittals for contract closeout

E. [Submittal list]

1.2 RELATED SECTIONS

A. Section 01630, Product Options and Substitutions.

1.3 TRANSMITTAL OF SUBMITTALS

A. Provide submittals as indicated in the specific specification sections.

B. Use a Routing Sheet to transmit submittals in the proper sequence.

1. Obtain copies at the preconstruction conference for use during construction.

1.4 SUBMITTAL PROCEDURE

A. Review submittals prior to transmittal to determine and verify field measurements, field construction criteria, manufacturers' catalog numbers, and conformance of submittals with Contract Documents. To certify compliance with these specifications:

1. Sign or initial each sheet of shop drawings.

2. Sign or initial each label on samples.

3. As a minimum, sign or initial the cover sheet of bound material.

B. For any proposed deviation from the Contract Documents, submit a written request to the Contract Administrator.

C. Submit for review the following number of copies of submittals:

1. [Seven] copies for AE/LANL use.

2. Additional number of copies for Contractor use as determined by the Contractor.

D. Submittal Clarity:

1. Drawings shall be clear and legible.

2. Manufacturer's Literature: Submit a minimum of one original of all manufacturers' printed material. Remaining number of submittals may be reproductions. Reproductions of original material shall be clear and legible.

E. A partial submittal consists of only a portion of the total required for a project. This is acceptable when it is prudent to submit for review certain submittals before the remaining submittals are available. Submit all items concurrently for which, due to coordination concerns, a simultaneous review is required. Include a separate Routing Sheet indicating the submittals transmitted with each numbered submittal package.

F. After review of the submittal package the "Action Code" will be indicated on the Routing Sheet and returned to the Contractor. Review of submittals will be indicated on each Routing Sheet by appropriate signature, stamp, and date. The number of copies of each submittal noted above for LANL use will be retained and the balance will be returned to the Contractor. The Contractor shall allow a minimum of [14 calendar days] for return of submittals.

G. LANL will utilize the following "Action Codes" to indicate the status of submittals resulting from the review, and the action required of the Contractor.

A - Reviewed. No comments.

B - Reviewed. Make corrections noted. Resubmission not required.

C - Reviewed. Revise and resubmit.

H. Use a Routing Sheet with all resubmittals indicating each item's submittal number and type suffixed "R1" for the first resubmittal, "R2" for the second resubmittal, and so forth.

I. Do not fabricate products or begin Work that requires submittals before such submittals are approved.

1. Exceptions: Field tests and inspection reports, concrete batch test reports, and contract closeout submittals.

1.5 DEFINITIONS OF SUBMITTAL TYPES FOR CONSTRUCTION

A. Calculations: The methods and results of calculations in documented form where specified.

B. Catalog Data: Standard printed information on materials, products and systems, which shows performance characteristics, dimensions, material of fabrication, and other characteristics necessary to assure conformity with the design requirements. Where other items or information not related to the work of this project are included in the literature submitted, the item(s) and/or information applicable to this project shall be clearly marked.

C. Certifications: A written statement, signed by a qualified party, attesting that items or services are in accordance with specified requirements. Typically, this written statement is accompanied by additional information to substantiate the statement.

D. Installation Instructions: Manufacturer's instructions, step-by-step if necessary, showing the field installation of parts, components, equipment, and other similar items.

E. Material List/Parts List/Design Mixes: A list of system or material components.

F. Performance Data/Curves: Performance data and/or curves for the proposed equipment to show compliance with contract documents.

G. Samples/Colors: Samples, including colors, of proposed materials.

H. Shop Drawings: Drawings necessary to show fabrication details to ensure compliance with contract documents.

I. Test Reports: Results of specified test requirements.

J. Wiring Diagrams: Drawings showing the point-to-point wiring of a piece of equipment or between pieces of equipment in a system.

1.6 SUBMITTALS FOR CONTRACT CLOSEOUT

A. Operation and Maintenance Data: Submit copies of data at least 15 days prior to any instruction of LANL personnel. Provide data in 8 1/2 x 11 inch 3 side ring binder with durable plastic covers.

1. Provide binders with clear pockets on front and binding edge for insertion of titles. Binders shall be not more than 75 percent full.

2. Prepare binder covers with printed title, “OPERATION AND MAINTENANCE INSTRUCTIONS/WARRANTIES,” subject matter of binder, and title of project.

3. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

4. Prepare a Table of Contents for each volume, with each product or system description identified, typed on 24-pound white paper.

a. Part 1: Directory-listing names, addresses, and telephone numbers of Contractors and major equipment suppliers.

b. Part 2: Operation and maintenance instructions arranged by specification section. For each category, identify names, addresses, and telephone numbers of Contractors and suppliers. Identify the following:

5. Content for mechanical equipment and systems, as appropriate.

a. Description of Unit and Component Parts:

1) Function, normal operating characteristics, and limiting conditions.

2) Performance curves, engineering data and tests.

3) Complete nomenclature and commercial number of replaceable parts.

4) Certification (specific) such as ASME for boiler.

5) Complete nameplate data for each major piece of equipment (i.e., boilers, chillers, cooling towers, pumps, fans, heat exchangers, and similar items).

b. Operating Procedures:

1) Start-up, break-in, routine and normal operating instructions.

2) Regulation, control stopping, shutdown and emergency instructions.

3) Summer and winter operating instructions.

4) Special operating instructions

c. Maintenance Procedures:

1) Routine operations.

2) Guide to "trouble-shooting."

3) Disassembly, repair and reassembly.

4) Alignment, adjusting and checking.

d. Servicing and Lubrication Schedule:

1) List of lubricants required.

e. Manufacturer's printed operating and maintenance instructions for the exact item of equipment supplied.

f. Description of sequence of operation by control manufacturer.

g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.

1) Predicted life of parts subject to wear.

2) Items recommended to be stocked as spare parts.

h. Control diagrams by controls vendor and as-installed control drawing by Contractor.

i. Each Contractor’s Coordination Drawings: As-installed color coded piping diagrams.

j. Charts of valve tag numbers, with the location and function of each valve.

k. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

l. Other data as required under pertinent sections of specifications.

6. Content for each electric and pneumatic system, as appropriate.

a. Description of System and Component Parts:

1) Catalog data containing information required for service, future additions or substitutions.

2) Function, normal operating characteristics, and limiting conditions.

3) Performance curves, engineering data and tests.

4) Complete nomenclature and commercial number of replaceable parts.

b. Circuit Directories of Panelboards:

1) Electrical service.

2) Controls.

3) Communications.

c. As-installed Color Coded Wiring Diagrams, i.e., ladder diagrams, point-to-point diagrams, loop diagrams, and similar items.

d. Operating Procedures:

1) Routine and normal operating instructions.

2) Sequences required.

3) Special operating instructions.

e. Maintenance Procedures:

1) Routine operations.

2) Guide to "trouble-shooting."

3) Disassembly, repair and reassembly.

4) Adjustment and checking.

f. Manufacturer's printed operating and maintenance instructions.

g. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

h. Other data as required under pertinent sections of specifications.

7. Prepare and include additional data when the need for such data becomes apparent during instruction of LANL personnel.

8. Provide additional requirements for operating and maintenance data in accordance with the respective sections of specifications.

9. Submit [2] copies of completed volume in near final form 15 days prior to final inspection. [One] copy will be returned after final inspection with LANL's/AE's comments. Revise content of documents as required prior to final submittal.

10. Submit 4 revised final volumes within [30] days after final inspection.

B. Project Record Documents.

1. Provide Project Record Documents in accordance with Section 01720.

C. Spare Parts and Maintenance Materials.

1. Provide products, spare parts, maintenance materials, and extra materials in quantities specified in individual specification sections.

2. Deliver to Project site and place in location as directed by Contract Administrator; obtain receipt prior to final payment.

D. Warranties.

1. Provide [notarized] copies.

2. Execute and assemble documents from Contractors, suppliers, and manufacturers.

3. Provide Table of Contents and assemble in binder with Operation and Maintenance Data.

4. For items of Work delayed beyond date of Substantial completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

1.7 SUBMITTAL LIST

A. Submittal List: Submittals shall be made for the items of hardware, equipment, and materials indicated in the attached Submittal List. Submittals marked with an asterisk (*) shall be in reproducible form.

B. The submittal list is a tabulation of the requirements identified in other specification sections. Any omission of an item from this list does not relieve the Contractor from the responsibility for submitting the item required by other specification sections.

C. Obtain copy of submittal list, including submittals that will be reviewed concurrently by LANL and AE, at the preconstruction meeting.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

| Submittal Types Key | | | | | |
|---|---|---|---|---|---|
| CA | = | Calculations | SD | = | Shop Drawings |
| CD | = | Catalog Data | TR | = | Test Reports |
| CT | = | Certifications | WD | = | Wiring Diagrams |
| II | = | Installation Instructions | OM | = | Operations & Maintenance Data |
| ML | = | Materials/Parts List/Design Mixes | RD | = | Project Record Documents |
| PD | = | Performance Data - Curves | SP | = | Spare Parts and Maintenance Materials |
| SC | = | Samples/Colors | WA | = | Warranties |

## SUBMITTAL LIST

| | | | CONSTRUCTION | | | | | | | | | | CONTRACT CLOSEOUT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBMITTAL NO. | SPEC SECTION | DESCRIPTION | CA | CD | CT | II | ML | PD | SC | SD | TR | WD | OM | RD | SP | WA |
| S1 | 03300 | Concrete Mix Design | X | X | X | | X | | | X | X | | | | | |
| S2 | 05120 | Structural Steel | | X | X | X | | | | X | | | | | | |
| S3 | 05500 | Metal Fabrications | | | X | | | | | X | | | | | | |
| S4 | 05520 | Handrails and Railings | | X | | | | | | X | | | | | | |
| S5 | 05531 | Gratings and Floor Plates | | X | | | | | | | | | | | | |
| S6 | 07141 | Cold Fluid-Applied Waterproofing | | X | X | X | | | | X | X | | | | | X |
| S7 | 08310 | Type Q (Bilco) Horizontal Access Door Specification | | X | | | | | | X | | | | | | X |
| M1 | 15050 | Basic Mechanical Materials and Methods | | | | | X | | | | | | | | | |
| M2 | 15130 | Hydronic Pumps | | X | | X | X | X | | | | | X | | | |
| M3 | 15170 | Motors | | X | X | X | X | | | | | X | X | | | |
| M4 | 15180 | Hydronic Piping | | X | X | X | | | | | | | | | | |
| E1 | 16130 | Boxes | | X | | | | | | | | | | | | |
| E2 | 16190 | Supporting Devices | | X | | | | | | | | | | | | |
| E3 | 16450 | Secondary Grounding | | X | | | | | | | | | | X | | |
| E5 | 16470 | Panelboards | | X | | | | | | | | | X | | | |
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END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products

B. Transportation and handling

C. Storage and protection

1.2 PRODUCTS

A. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

B. Provide interchangeable components of the same manufacturer for components being replaced.

1.3 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.4 STORAGE AND PROTECTION

A. Store and protect Products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive Products in weather tight, climate controlled, enclosures in accordance with the manufacturer’s requirements.

D. For exterior storage of fabricated Products, place on sloped supports above ground.

E. Provide off-site storage and protection when site does not permit on-site storage or protection.

F. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of Products.

G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.

J. Manually rotate shafts of rotating equipment (fans, pumps, cooling towers, etc.) weekly from time of arrival to start-up.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01630

PRODUCT OPTIONS AND SUBSTITUTIONS

## PART 1 GENERAL

### 1.1 SUBSTITUTIONS

"Or approved equal" is always implied after a brand name, patented process or catalog number. The Contractor may substitute any brand or process approved as an equal by the specifying Architect/Engineer. The only exception is where "no substitution" is specified. See General Provision "Material and Workmanship".

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout Procedures

B. Final Cleaning

C. Adjusting

D. Instructions for LANL personnel

1.2 RELATED SECTIONS

A. Section 01720, Project Record Documents

1.3 CLOSEOUT PROCEDURES

A. Upon completion of the work certify that:

1. Contract Documents have been reviewed.

2. Work has been inspected for compliance with Contract Documents.

3. Work has been completed in accordance with the Contract Documents.

4. Equipment and systems have been tested as required, and are operational.

5. Work is completed and ready for final inspection.

B. Should the Work be found to be incomplete or defective, LANL will notify the Contractor in writing, listing the incomplete or defective work.

C. Contractor shall correct the deficiencies promptly, and notify LANL when the Work is ready for reinspection.

D. When the Work is determined to be acceptable, the Contract Administrator will request Contractor to make closeout submittals.

1.4 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to a sanitary condition.

D. Replace filters of operating water and air equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean project site; sweep paved areas, rake clean landscaped surfaces.

G. Remove waste and surplus materials, rubbish, and construction facilities from project site.

H. Replace lamps in light fixtures used during construction.

I. Remove start-up screens and clean strainer.

1.5 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.6 INSTRUCTIONS FOR LANL PERSONNEL

A. Prior to final inspection or acceptance, fully instruct LANL designated operating and maintenance personnel in the operation, adjustment and maintenance of equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction: Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

C. Use personnel skilled in the operation of equipment. Instructions for major equipment shall be provided by equipment manufacturers' representatives.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Project Record Documents

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals:

1. At the completion of construction, deliver the Project Record Documents to the Contract Administrator.

2. Transmit the Project Record Documents with a cover letter listing:

a. Date

b. Project title and number

c. Contractor's name, address, and telephone number

d. Number and title of each Record Document

e. Signature of Contractor or authorized representative

1.3 MAINTENANCE OF DOCUMENTS

A. Maintain at project site a record copy of the following Project Record Documents:

1. Drawings

2. Specifications

3. Amendments

4. Change orders and other modifications to the Contract

5. Reviewed shop drawings, product data, and samples

6. Field test records

7. Inspection certificates

8. Manufacturer's certificates

9. Specified installer/tradesman certificates

B. Store Project Record Documents in Field Office apart from other documents. Provide separate files, racks, and secure storage for Project Record Documents.

C. Label and file Project Record Documents in accordance with Section number listings in Table of Contents of these Specifications. Label each document "PROJECT RECORD DOCUMENTS" in large, legible, printed letters.

D. Maintain Project Records Documents in a clean, dry and legible condition.

E. Keep Project Record Documents available for periodic inspection by the Construction Inspector.

1.4 RECORDING

A. Use an erasable red pencil (not ink or indelible pencil) to clearly record information or changes on the drawings by graphic line and note as required. Use an erasable yellow pencil to clearly mark for verification all major components shown as constructed.

B. Use different colors for the overlapping changes if required for clarification.

C. Record information concurrently with construction progress. Do not conceal any work until required information is recorded. Date entries reflecting change.

D. Legibly mark each item on the drawings to record actual construction, including:

1. Measured depths of elements of foundation in relation to finish first floor datum.

2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to LANL Labwide Survey Control Network, indicating the origin of the New Mexico State Plane Coordinates.

3. Surveyed actual building placement, referenced to the LANL Labwide Survey Network, indicating the origin of the New Mexico State Plane Coordinates.

4. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.

5. Field changes of dimension and detail.

6. Changes made by Contract modifications.

7. Details not on original Drawings.

8. References to related shop drawings and Contract modifications.

E. Specifications: Legibly mark each item to record actual construction, including changes made by amendment and Contract modifications.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 02072

MINOR DEMOLITION FOR REMODELING

PART 1 GENERAL

.1 SECTION INCLUDES

A. Protection of existing materials

B. Disposal of materials

C. Identification of utilities

D. Demolition

.2 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of capped utilities.

.3 REGULATORY REQUIREMENTS

A. Do not close or obstruct egress width to exits.

B. Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to the Contract Administrator.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

.1 PREPARATION

A. Protect existing materials which are not to be demolished.

B. Do not damage existing materials designated to be reused.

C. Identify location of existing utilities.

.2 DEMOLITION REQUIREMENTS

A. Conduct demolition to minimize interference with occupied building areas.

B. If existing structure appears to be in danger, cease operations and notify the Contract Administrator immediately. Do not resume affected operations until directed by the Contract Administrator.

C. If hazardous or contaminated materials are discovered, cease operations immediately and notify Contract Administrator for direction.

D. Maintain protected egress and access to the work.

.3 DEMOLITION

A. Disconnect, remove, cap and identify designated utilities within demolition areas.

B. Demolish in an orderly and safe manner.

C. Remove demolished materials from site as work progresses and haul to the Los Alamos County Landfill. Upon completion of work, leave areas in clean condition.

D. Do not burn or bury materials on site.

E. Remove temporary work.

END OF SECTION

SECTION 03300

REINFORCED CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formwork, shoring, bracing, and anchorage

B. Concrete reinforcing and accessories

C. Cast-in-place concrete

D. Control, expansion, and contraction joint devices associated with concrete work

1.2 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals.

B. Concrete Design Mixes

1. Submit separate mix design for:

a. Each concrete strength

b. Each range of air content

c. Each nominal maximum aggregate size

d. Concrete to be pumped

e. Concrete with identifiable admixtures

2. Include the following information with each design:

a. Quantity of water

b. Type, brand, certification, and quantity of cement

c. Source, certification, and quantity of each nominal maximum size of aggregate

d. Type, brand, sources, certification and quantity of admixture, if used

e. Type, source, certification, and quantity of fly ash, if used

f. Water/cement ratio

g. Air-content

h. Slump

i. Strength test record, in accordance with ACI 301

C. Batch Tickets

1. Submit 2 legible copies of the batch ticket for each load of concrete to the Contract Administrator.

2. Conform to the requirements for batch tickets in accordance with ASTM C94. Include the following information:

    a. Name of ready-mix batch plant

    b. Serial number of ticket

    c. Date

    d. Truck number

    e. Name of purchaser

    f. Specific designation of job (name and location)

    g. Specific class or designation of the concrete in conformance with that employed in job specifications

    h. Amount of concrete in cubic yards (or cubic meters)

    i. Time loaded or of first mixing of cement and aggregates

    j. Water added by receiver of concrete and his initials

    k. Reading of revolution counter at the first addition of water

    l. Type, brand, and amount of cement

    m. Type, brand, and amount of admixtures

    n. Information necessary to calculate the total mixing water added by the producer. Total mixing water includes free water on the aggregates, water, and ice batched at the plant, and water added by the truck operator from the mixer tank.

    o. Maximum size of aggregate.

    p. Weights of fine and coarse aggregate.

    q. Ingredients certified as being previously approved

    r. Signature or initials of ready-mix representative

3. Record on each, the location where placed in structure and time of placement.

D. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel, bending and cutting schedules, supporting, and spacing devices, placement of waterstop material.

E. Catalog Data: Provide data on waterstop, joint devices, attachment accessories, and admixtures.

F. Test reports of concrete field testing per PART 3, Field Quality Control.

1.3 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301, 318, 347, and 350.

B. Acquire cement from same source for all work.

C. Acquire aggregate from same source for all work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.1 WOOD FORM MATERIALS AND ACCESSORIES

A. Softwood Plywood: PS 1, C Plugged Grade, Group 2.

B. Form Ties: Snap off type, galvanized metal cone type with waterproofing washer free of defects that could leave holes larger than 1 in. in concrete surface.

C. Form Release Agent: Colorless mineral oil which will not stain concrete, absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

2.2 REINFORCING AND ACCESSORIES

A. Reinforcing Steel: ASTM A 615, grade 60 deformed bars; ties and stirrups, grade 40.

B. Chairs, Bolsters, Bar Supports, Spacers: Size and shape for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor barrier puncture. Special chairs, bolsters, bar supports, spacers adjacent to weather exposed concrete surfaces to be plastic coated steel type; size and shape as required.

C. HVA Adhesive Anchoring System as provided by Hilti for anchoring reinforcing bars in concrete.

2.3 CONCRETE MATERIALS

A. Cement shall be ASTM C150, Type I or Type II.

B. Fine and Coarse Aggregates: Conform to ASTM C33.

C. Water: Potable water that is clean and not detrimental to concrete.

2.4 ADMIXTURES

A. Air Entrainment: Conform to ASTM C260.

B. Chemical: Conform to ASTM C494.

C. Fly Ash: Conform to ASTM C618, type F.

2.5 ACCESSORIES

A. Bonding Agent: Polymer resin emulsion

B. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days

C. Waterstop: Waterstop-RX 101T: 1-1/4" x ½" , Product RX 101T by CETCO, Colloid Environmental Technologies Company.

2.6 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301, proportioning on the basis of previous field experience or trial mixtures method, for $f_{cr}$ = the larger of:

$f_{cr}$ $f'_c$ + 1.34s, or

$f_{cr}$ $f'_c$ + 2.33s - 500, where:

$f_{cr}$ = required average compressive strength of concrete mix design, psi

$f'_c$ = specified design compressive strength of concrete, psi

s = standard deviation, psi

If a suitable record of tests is not available to establish a standard deviation, use the following:

$f_{cr}$ $f'_c$ + n, where:

n = additional required strength, psi, for a specified $f'_c$:

n = 1000 psi for $f'_c$ = less than 3000 psi.

n = 1200 psi for $f'_c$ = 3000 to 5000 psi.

n = 1400 psi for $f'_c$ = over 5000 psi.

C. Provide concrete meeting the following criteria:

1. Exterior concrete exposed to freezing and thawing:

a. Compressive strength, $f'_c$: 4,000 psi @ 28 days

b. Maximum nominal aggregate size: 0.75 in.

c. Maximum water / cement ratio: 0.44

d. Slump: 3 in. plus or minus 1 in. tolerance

e. Air content: 4 to 6 percent

D. Use accelerating admixtures in cold weather only when approved by the Contract Administrator. Use of admixtures will not relax cold weather placement requirements.

E. Do not use calcium chloride as an admixture.

F. Use set retarding admixtures during hot weather only when approved by the Contract Administrator.

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork. Ensure that dimensions agree with the Drawings.

B. Verify that anchors, seats, plates, reinforcement, waterstop, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

### 3.2 FORMWORK ERECTION

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling, stripping and removal of remaining principal shores. Do not damage concrete during stripping.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval from the Contract Administrator before framing openings (in structural members) which are not detailed on Drawings.

F. Provide chamfer strips on external corners of beams, joists, columns, and walls.

G. Apply form release agent prior to placement of reinforcing steel, anchoring devices, and embedded items.

H. Do not apply form release agent where concrete surfaces receive special finishes or applied coverings that are effected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

I. Provide formed openings where required for items to be embedded in or passing through concrete work.

J. Locate and set in place items that cast directly into concrete.

K. Clean formed cavities of debris prior to placing concrete.

L. During cold weather, remove ice and snow from within forms. Do not use deicing salts or water to clean out forms. Use compressed air or other means to remove foreign matter.

M. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and other imposed loads without excessive deflection or creep.

3.3 REINFORCING PLACEMENT

A. Place, support, and secure reinforcement against displacement. Do not deviate from required position.

B. Do not displace or damage vapor barrier.

C. Maintain concrete cover around reinforcing as shown on the drawings or as follows, whichever is the most stringent:

| | Item | Minimum cover, inch |
|---|---|---|
| 1. | Concrete cast against and permanently exposed to earth: | 3 |
| 2. | Concrete exposed to earth or weather: | |
| | #6 through #18 bars | 2 |
| | #5 bar, W31 or D31 wire, and smaller | 2 |
| 3. | Concrete not exposed to weather or in contact with ground: | |
| | Slabs, walls, joists: | |
| | #11 bar and smaller | 3/4 |
| 4. | Beams, columns: | |
| | Primary reinforcement, ties, stirrups, spirals: | 1-1/2 |

3.4 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

~~B.~~ In locations where new concrete is to be dowelled to existing work, drill holes in existing concrete, insert steel dowels and embed and anchor per Section 2.2 D.

3.5 PLACING CONCRETE

A. Place concrete in accordance with ACI 301.

B. Notify the Contract Administrator a minimum of 24 hours prior to commencement of concreting operations.

C. Ensure that reinforcement, inserts, embedded parts, formed joint fillers, joint devices, waterstops and formwork are not disturbed during concrete placement.

D. Place concrete continuously between predetermined expansion, control, and construction joints.

E. Screed top of wall level, maintaining surface flatness of maximum ¼ inch in 10 feet.

3.6 CONCRETE FINISHING

A. Provide formed concrete surfaces to be left exposed with smooth rubbed finish.

B. Finish concrete floor surfaces in accordance with ACI 301.

C. Steel trowel surfaces that are scheduled to be exposed.

D. Finish concrete surfaces in accordance with waterproofing manufacturers recommendations.

3.7 CURING AND PROTECTION

A. Immediately after placement, protect concrete from pre-mature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for complete hydration of cement and hardening of concrete.

C. Cure floor surfaces in accordance with ACI 308.

3.8 FIELD QUALITY CONTROL

A. Provide a certified testing agency to perform field testing in accordance with ACI 301.

B. Submit proposed mix design of each class of concrete to the Contract Administrator for approval prior to commencement of work.

C. Inform the Contract Administrator 48 hours in advance of concrete placement operations to allow for witnessing of testing.

D. The Testing Agency will perform the following tests and collect strength cylinders on one batch in every 50 cubic yards of concrete placed or once a day when less than 50 cubic yards is placed.

1. Record temperature of concrete in accordance with ASTM C1064.

2. Perform slump test in accordance with ASTM C143.

3. Perform air content test in accordance with ASTM C231, pressure method.

4. The testing agency will take 4 concrete strength test cylinders in accordance with ASTM C31.

E. The Testing Agency will test the strength test cylinders in accordance with ASTM C39 at 7 days and 28 days.

F. Written documentation of all tests performed and all results shall be provided to the Contract Administrator.

3.9 CONCRETE ACCEPTANCE CRITERIA

A. Fresh Concrete

1. Temperature - Less than 90 degrees F

2. Slump - per Section 2.6

3. Air content - per Section 2.6

4. Drum revolution counter - 100 to 300 revolutions within 1-1/2 hours after initial mixing.

B. Strength

1. Concrete strength is satisfactory if the average of all sets of 3 consecutive strength test results equal or exceed the specified 28 day strength $f'_c$ and no individual strength test result falls below the specified 28 day strength $f'_c$ by more than 500 psi.

C. Appearance

1. Free from honeycombs and embedded debris.

D. Construction Requirements

1. Conforming to required lines, details, dimensions, and tolerances specified for construction.

3.10 DEFECTIVE CONCRETE

A. Defective concrete is concrete not conforming to acceptance criteria in Section 3.9.

B. Do not accept or place defective concrete that is not in conformance with acceptance criteria. Return the fresh concrete to the supplier.

C. Replace defective concrete not meeting strength criteria, at Contractor's expense. The Contractor may, at its expense, evaluate the concrete's in-place strength by testing 3 core samples for each strength test where LANL cured cylinders where more than 500 psi below $f'_c$ in accordance with ACI 301 and ASTM C42. Fill core holes in accordance with ACI 301. Provide testing and test results to ensure the watertightness and integrity of the finished wall will not be compromised by the cored holes.

D. Replace defective concrete not meeting appearance criteria, at Contractor's expense. The Contract Administrator may allow repair of defective concrete at Contractor's expense, provided the watertightness of the concrete will be maintained.

E. Replace concrete not in conformance with details, tolerances, and other construction requirements at Contractor's expense.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Structural steel

B. Shop applied finishes and field applied touchup

C. Grout under base plates

1.2 SUBMITTALS

A. Submit the following in accordance with the requirements of Sections 01300, Submittals.

1. Certifications

a. Provide certificate of compliance for structural steel and high strength load indicator bolts.

b. Provide Welders Certification for all welders in accordance with AWS D1.1.

2. Shop Drawings

a. Provide shop drawings in accordance with the AISC Code of Standard Practice and the AISC Structural Steel Detailing Manual.

b. Do not fabricate structural steel until shop drawings have been approved by the Contract Administrator.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle structural steel:

1. With equipment of adequate capacity.

2. Without overstressing or permanently deflecting material.

3. Without damaging finish.

B. Deliver manufactured materials in original unopened packages, containers, or bundles with manufacturer's label intact and legible.

C. Store materials off ground, under cover, and away from damp surfaces.

D. Remove damaged, unlabeled or unsatisfactory materials that do not meet this specification from the job site.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. Provide structural steel conforming to ASTM A36, A572.

B. Provide steel pipe conforming to ASTM A53, Type E or S, Grade B.

C. Provide steel tube conforming to ASTM A500, Grade B.

D. Provide high strength, load indicator bolts and nuts conforming to ASTM A325.

E. Provide anchor bolts and tie rod materials conforming to ASTM A307.

F. Provide primer for exterior application conforming to FS TT-P-31, Paint Iron Oxide, Ready Mixed, Red.

G. Provide welding electrodes conforming to AWS D1.1, Table 4.1.1, E70XX, low hydrogen.

H. Provide Kwik Bolt II 304 Stainless Steel Anchors as manufactured by Hilti.

I. Provide HSLG Heavy Duty Sleeve Anchors as manufactured by Hilti.

### 2.2 FABRICATION

A. Fabricate structural steel in accordance with:

1. AISC Specifications, as applicable
2. AISC Code of Standard Practice for Steel Buildings and Bridges
3. Approved shop drawings

B. Workmanship

1. Provide finished members:
   a. Straight or true to required lines and curvatures
   b. Free of twists, buckles and bends
2. Provide bolt holes:
   a. Accurately spaced to required centers
   b. Punched, drilled, or sub-drilled and reamed

C. Welding

1. Conform to AWS D1.1 and the AISC Specification.
2. Provide run-off tabs for groove welds.
3. Clean welds by removing all slag, flux and spatter prior to finishing.
4. Certify welder in accordance with AWS D1.1.

2.3 FINISHING

A. Shop Prime

1. Perform finishing work in accordance with:

a. AISC Specifications, as applicable.

b. Steel Structures Painting Council.

2. Prepare surfaces in accordance with SSPC-SP2 "Hand Tool Cleaning" or SSPC-SP3, "Power Tool Cleaning."

3. Paint in accordance with the requirements of SSPC-PA1, "Shop, Field, and Maintenance Painting." Apply one coat of specified primer, minimum.

4. Provide 1.5-mils thick paint system of specified primer, measured in accordance with SSPC-PA2.

B. Galvanized

1. Galvanize all structural steel members to ASTM A123.

C. Do not prime surfaces that will be in contact with concrete, field welded, and bolted with high strength bolts.

PART 3 EXECUTION

3.1 ERECTION

A. General

1. Erect structure in accordance with the AISC Code of Standard Practice.

2. Erect structure plumb, square, straight and true prior to finishing all connections. Keep tolerances within those stated in the AISC Code of Standard Practice.

3. Use temporary guys and/or tie rods to plumb and square structure.

4. Temporarily bolt or clamp all field connections while adjusting structure and making permanent connections.

B. Bolting

1. Do not correct mismatched holes by reaming without the approval of the Contract Administrator.

2. Do not drift or burn holes.

3. Set anchor bolts with templates.

4. Set anchor bolts to the tolerances specified by AISC Code of Standard Practice for Steel Buildings and Bridges.

5. Make steel to steel bolted connections with specified high strength load indicator bolts.

6. Use beveled washer when the slope of surfaces exceeds 1:20.

7. Install hardened steel washers in accordance with the requirements of the AISC: Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

8. Install load indicator bolts in accordance with the directions of the manufacturer.

C. Welding: Refer to "Fabrication" in Part 2.

3.2 GROUTING

A. Fill void between steel and concrete with grout.

B. Install grout in conformance with manufacturer's instructions.

C. Press edges of grout to a 1 to 1 slope.

D. Cure grout for 7 days according to the Manufacturer’s recommendations.

3.3 TOUCH-UP OF FINISHES

A. Repair after erection, areas where finish has been abraded, damaged, or burned and all field welds, bolts, nuts, and washers.

B. Apply touch-up paint in accordance with Specification SSPC-PA1, Section entitled "Field Painting."

C. Apply galvanizing material to any galvanized surfaces damaged after welding.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shop fabricated metal items; galvanized, prime painted, or mill finish.

1.2 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals.

1. Shop drawings describing each fabricated items

a. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

b. Include erection drawings, elevations, and details where applicable.

c. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

2. Welders certification

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle metal items:

1. With equipment of adequate capacity.

2. Without overstressing or permanently deflecting material.

3. Without damaging finish.

B. Store materials off ground, under cover, and away from damp surfaces.

C. Remove damaged, unlabeled or unsatisfactory materials which do not meet this specification from job site.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide aluminum sections conforming to ASTM B221, 6061-T6 alloy, mill finish.

B. Provide aluminum plates conforming to ASTM B209, 6061-T6 alloy, mill finish.

C. Provide welding materials in accordance with AWS D1.1 and D1.2 for materials being welded.

D. Provide general use primer conforming to FS TT-P-31, red; for shop application and field touch-up.

E. Provide touch-up primer for galvanized surfaces conforming to FS TT-P-641.

F. Provide primer for aluminum to be in contact with steel conforming to FS TT-P-645.

G. Provide stainless anchors, steel bolts, nuts and washers for all connections.

2.2 FABRICATION

A. Verify dimensions on site prior to shop fabrication.

B. Fabricate items with joint tightly fitted and secured.

C. Fit and shop assemble in largest practical sections, for delivery to site.

D. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.

E. Make exposed joints butt tight, flush, and hairline.

F. Supply components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

G. Certify welders in accordance with AWS D1.1 and AWS D1.2.

2.3 FINISH OF STEEL FABRICATIONS

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact bond with concrete or where field welding is required.

PART 3 EXECUTION

3.1 PREPARATION

A. Obtain Contract Administrator approval prior to site cutting or making adjustments to metal items.

B. Clean and strip site primed steel items to bare metal where site welding is scheduled.

C. Make provision for erection loads with temporary bracing. Keep work in alignment.

D. Supply items required to be cast into concrete with setting templates, to appropriate Sections.

3.2 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Perform field welding in accordance with AWS D1.1 and AWS D1.2.

C. After installation, touch-up field welds and scratched or damaged surfaces on metal fabrications with primer.

D. Submit written documentation of weld testing and test results to the Engineer of Record.

END OF SECTION

SECTION 05520

HANDRAILS AND RAILINGS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Steel pipe handrails, balusters and fittings.

### 1.2 DESIGN REQUIREMENTS

A. Design, fabricate, and install railing assembly, wall rails and attachments to resist a lateral force of 200 pounds applied in any direction, at any point on the railing without causing damage or permanent set.

B. Comply with NFPA 101, Life Safety Code.

### 1.3 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals.

1. Catalog data indicating prefabricated components such as mounting brackets, trim pieces, etc.

2. Shop drawings indicating profiles, sizes, connection attachments, anchorage, type and size of fasteners, and accessories.

## PART 2 PRODUCTS

### 2.1 STEEL RAILING SYSTEM MATERIALS

A. Use pipe conforming to ASTM A500, Grade B, Schedule 40.

B. Make rails and posts of 1 1/2 inch outside diameter steel pipe with welded joints.

C. Use cast steel fittings, elbows, T shapes, wall brackets, escutcheons, etc..

D. Provide mountings for casting in concrete, or mounting to steel members, as shown on Drawings.

E. Use stainless steel, flush, countersunk screws or bolts, consistent with design of railing system.

F. Use concealed splice connectors.

G. Apply SSPC 15, Type 1, red oxide shop primer.

### 2.2 FABRICATION

A. Fit and shop assemble components in largest practical sizes for delivery to site.

B. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

C. Provide anchors and fittings required for fastening assembly to structure. Fabricate anchors and related components of same material, with same finish, as post and railing fabrication.

D. Continuously seal exterior components by continuous welds. Drill condensate drainage holes at bottom of members in locations that will not allow water intrusion.

E. Join interior components with continuous welds; grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

F. Accurately form components to fit each other and to building structure.

## PART 3 EXECUTION

### 3.1 INSPECTION

A. Verify that field conditions are acceptable and are ready to receive this work.

### 3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast in concrete, or attached to steel members with setting templates, to appropriate trades.

### 3.3 INSTALLATION

A. Install components plumb and level, accurately fitted, and free from distortion or defects.

B. Field weld anchors as indicated on shop drawings. Grind welds smooth, and touch up with primer.

C. Assemble railings with spigots and sleeves to provide tight joints and secure installation.

D. Apply finish as directed by the Contract Administrator.

### 3.4 ERECTION TOLERANCES

A. Maximum variation from plumb is 1/4 inch per story, non-cumulative.

B. Maximum offset from true alignment is 1/4 inch.

C. Maximum out-of-position is 1/4 inch.

END OF SECTION

SECTION 05531

GRATINGS AND FLOOR PLATES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formed steel gratings

B. Formed aluminum gratings

C. Molded glass fiber gratings

1.2 DESIGN REQUIREMENTS

A. Use ANSI/NAAMM A202.1 for design loads

B. Design for live load of 100 psf.

C. Maximum deflection under live load is 1/240 of span

1.3 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals:

1. Catalog data with details of grate construction and span and deflection tables.

PART 2 PRODUCTS

2.1 GRATING MATERIALS

A. Use formed and galvanized steel conforming to ASTM A36, G90.

B. Use molded glass fiber reinforced plastic to match existing fiberglass materials.

C. Provide appropriate anchorage and splicing fittings.

2.2 FLOOR PLATE MATERIALS

2.3 GRATING FABRICATION

A. Fabricate grating to accommodate design loads.

B. Mechanically clinch joints of intersecting metal grating sections.

C. Provide non-slip top surface.

2.4 GRATING FABRICATION

A. Shear steel grating to size required, and grind edges to provide an “eased” edge.

B. Galvanized after cutting and grinding.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify that opening sizes and dimensional variations are acceptable to receive grating.

B. Verify that supports are correctly positioned.

3.2 INSTALLATION

A. Install components in correct position, plumb, and level.

B. Secure to prevent movement with appropriate fittings.

END OF SECTION

SECTION 07141

COLD FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Single-component, modified polyurethane waterproofing.

B. Related Sections include the following:

1. Division 3, Section 03300, Reinforced Concrete.

1.3 PERFORMANCE REQUIREMENTS

A. Provide waterproofing membrane that prevents the passage of water.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

D. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.

E. Sample Warranty: Copy of special waterproofing manufacturer's and Installer's warranty stating obligations, remedies, limitations, and exclusions before starting waterproofing.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is authorized by waterproofing manufacturer to install manufacturer's products.

B. Source Limitations: Obtain waterproofing materials through one source from a single manufacturer.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted

weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.

1. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

A. Special Manufacturer's Warranty: Written warranty, signed by waterproofing manufacturer and Installer agreeing to repair or replace waterproofing that does not comply with requirements or that does not remain watertight within specified warranty period.

1. Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate that exceed 1/16 inch (1.6 mm) in width.

2. Warranty Period: Five years after date of Substantial Completion.

B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

B. Products: Subject to compliance with requirements, provide the following products:

1. Single-Component, Modified Polyurethane Waterproofing:

a. Sonneborne, Div. of ChemRex Inc.; HLM 5000.

2. One-Component Elastomeric Gun-Grade Polyurethane Sealant:

a. Sonneborne, Div. of ChemRex Inc.; Sonolastic NP 1.

2.2 WATERPROOFING MATERIALS

A. General: Provide waterproofing materials recommended by manufacturer to be compatible with one another and able to develop bond to substrate under conditions of service and application, as demonstrated by waterproofing manufacturer based on testing and field experience.

1. Produce waterproofing materials suitable for application to vertical, horizontal, and sloped substrates, as applicable.

2. Provide waterproofing materials with not less than 90 percent solids.

B. Cold Fluid-Applied Waterproofing: Comply with ASTM C 836, with manufacturer's written physical requirements, and as follows:

1. Single-component, modified polyurethane waterproofing.

2.3 AUXILIARY MATERIALS

A. Primer: Manufacturer's standard, factory-formulated polyurethane or epoxy primer.

B. Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

C. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.

1. Backer Rod: Closed-cell polyethylene foam.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.

2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

## 3.3 PREPARATION AT TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to ASTM C 898 and manufacturer's written instructions.

B. Prime substrate, unless otherwise instructed by waterproofing manufacturer.

C. Apply a double thickness of waterproofing and embed a joint reinforcing strip in preparation coat when recommended by waterproofing manufacturer.

1. Provide sealant cants around penetrations and at inside corners of deck-to-wall and wall-to-wall butt joints when recommended by waterproofing manufacturer.

## 3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 898 and waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.

1. Comply with ASTM C 1193 for joint-sealant installation.

2. Apply bond breaker between sealant and preparation strip.

3. Prime substrate and apply a single thickness of preparation strip extending a minimum of 3 inches (75 mm) along each side of joint. Apply a double thickness of waterproofing and embed a joint reinforcing strip in preparation coat.

## 3.5 WATERPROOFING APPLICATION

A. Apply waterproofing according to ASTM C 898 and manufacturer's written instructions.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate.

D. Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases, with an average dry film thickness of 60 mils (1.5 mm) and a minimum dry film thickness of 50 mils (1.3 mm) at any point.

2. Apply waterproofing to prepared wall terminations and vertical surfaces.

3. Verify wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m). Submit verification report in writing to LANL and to Engineer of Record.

3.6 FIELD QUALITY CONTROL

A. Flood Testing: Flood test each sump area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

1. Flood to an average depth of normal operation.

2. Flood each area for 24 hours.

3. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

B. LANL will provide independent testing personnel to observe flood testing and examine wall, deck, and terminations for evidence of leaks during flood testing. Notify the Contract Administrator five days prior to the start of testing.

C. Provide written test report documentation to Engineer of Record.

3.7 CURING, PROTECTING, AND CLEANING

A. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.

1. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 08310

HORIZONTAL ACCESS DOOR SPECIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Work included: Furnishing and installing factory fabricated vault access door.

B. Related Work: Section 05120 Structural Steel, Section 05500 Metal Fabrications.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM),100 Bar Harbor Drive, West Conshocken, PA 19428-2959; (215) 299-5400, fax (215) 977-9679

1. ASTM A 36-93a: Standard Specification for Structural Steel

2. ASTM A-123: Standard Specifications for Zinc (hot-dip galvanized) Coatings on Iron and Steel.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's product data for all materials in this specification.

B. Shop Drawings: Show profiles, accessories, location, and dimensions.

C. Contract Closeout: Vault access door manufacturer shall provide the manufacturer's Warranty prior to the contract closeout.

1.4 PRODUCT HANDLING

A. All materials shall be delivered in manufacturer's original packaging.

B. Store materials in a dry, protected, well-vented area. The contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

C. Remove protective wrapping immediately after installation.

1.5 SUBSTITUTIONS

A. Proposals for substitution products shall be accepted only from bidding contractors and not less than (10) working days before bid due date. Contractor guarantees that proposed substitution shall meet the performance and quality standards of this specification.

B. Proposed substitutions shall match the dimensions and fit into the details shown on the plans.

1.6 JOB CONDITIONS

A. Verify that other trades with related work are complete before installing vault access door.

B. Mounting surfaces shall be straight and secure; substrates shall be of proper width.

C. Refer to the construction documents, shop drawings, and manufacturer's installation instructions.

D. Observe all appropriate OSHA safety guidelines for this work.

1.7 WARRANTY/GUARANTEE

A. Manufacturer's standard warranty: Materials shall be free of defects in material and workmanship for a period of (5) five years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. The BILCO Company, P.O. Box 1203, New Haven, CT 06505; 1-203-934-6363, Fax: 1-203-933-8478, Web: www.bilco.com.

2.2 ACCESS DOOR

A. Furnish and install where indicated on plans vault access door Type Q, size: width = 25 inches x length = 60 inches. Length denotes hinge side. Length and width denote clear opening with the door in the open position. The vault access door shall be single leaf. The vault access door shall be pre-assembled from the manufacturer.

B. Performance characteristics:

1. Cover: Shall be reinforced to support a minimum live load of 150 psf (732 kg/m2) with a maximum deflection of 1/150th of the span.

2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.

3. Operation of the cover shall not be affected by temperature.

C. Cover: Shall be 1/4" (6.3 mm) steel diamond pattern plate. A slot in the cover shall be as shown on the plans. A hinged cover plate will be required to cover the slot opening, as described in Section 2.02 H.7.

D. Frame: Shall be 3” x 3” x 1/4" (6.3 mm) steel angle, without strap anchors welded to the exterior. Holes in the frame shall be provided for plug welds. Along the long side of the frame opposite the edge that is hinged, holes shall be located on the horizontal leg of the support angle, within 6 inches of each end, and spaced at a maximum of 12 inches on center along the length, as defined in Part A of this section. Hole diameter shall be 1/2", and shall be centered on the leg of the frame support angle.

E. Hinges: Shall be specifically designed for horizontal installation and shall be bolted to the underside of cover.

F. Lifting mechanisms: Cam-action hinges shall pivot on torsion bars to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing.

G. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover.

H. Hardware:

1. Hinges: Cast steel cam-action hinges which pivot on torsion bars shall be provided.

2. Cover shall be equipped with a steel hold open arm which automatically locks the cover in the open position.

3. Cover shall be fitted with the required number and size of torsion bars.

4. A Type 316 stainless steel snap lock with fixed handle shall be mounted on the underside of the cover.

5. Hardware: Shall be zinc plated and chromate sealed

6. Latching Device: Shall be a recessed padlock hasp covered by a hinged lid, flush with the surface.

7. Hinged cover plate over slot in cover: Cover plate shall be made of the same material as the cover, be flush with the surface in the closed position, open at least 135 degrees in the open position, hinged parallel to the width (as defined in Section 2.02 A), and shall have a 1/2 inch diameter finger-hole for opening the cover plate. See plans for slot location, finger-hole location and dimensions.

I. Finish: Factory finish shall be a hot-dip galvanized finish.

## PART 3 EXECUTION

### 3.1 INSPECTION

A. Verify that the vault access door installation will not disrupt other trades. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

### 3.2 INSTALLATION

A. Submit product design drawings for review and approval to the architect or specifier before fabrication.

B. The installer shall check as-built conditions and verify the manufacturer's vault access door details for accuracy to fit the application prior to fabrication. The installer shall comply with the vault access door manufacturer's installation instructions.

C. The installer shall furnish mechanical fasteners consistent with the vault access door manufacturer's instructions.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

## PART 1 GENERAL

### 1.1 SPECIAL REQUIREMENTS

A. Furnish equipment and materials as shown on the Drawings, as specified herein, and as required to provide a complete operating system.

B. Verify and establish dimensions, clearances, and field conditions prior to the start of fabrication and/or installation.

### 1.2 QUALITY ASSURANCE

A. New Products

1. All piping, valves, equipment and miscellaneous accessories and appurtenances will be new. No previously used material of any kind will be permitted to be incorporated into any of the systems.

B. Equipment Design

1. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers will be designed in conformity with applicable technical standards and suitable for maximum working pressure, test pressure and temperatures required.

C. Equipment Installation

1. Obtain manufacturer's printed installation instructions to aid in properly executing work of installing equipment whenever such instructions are available.

2. Erect equipment in a neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviation from arrangements indicated may be made, as approved.

D. Packaged Equipment

1. Packaged equipment, where specified, will be completely factory assembled equipment.

2. Packaged equipment will include all mechanical and electrical components mounted on a common base or in a common enclosure with all piping, controls and wiring factory installed ready to be incorporated into the mechanical system.

E. Balancing of Rotating Equipment

1. Wherever static and dynamic balancing of equipment is specified, vibrational velocities measured at the fan or pump shaft or other rotating shaft bearing caps, will not exceed 0.1 inches per second peak in any plane.

F. Products

1. Design Basis Manufacturer: The first name referenced in the specifications or listed on the Drawings is the “Basis of Design”. This has established the

following:

a. The quality of the product with the necessary features essential to satisfy the minimum requirements for its respective application.

b. The minimum working clearances allocated for service and maintenance.

2. Alternate Manufacturers: It is incumbent upon the contractor to ensure that products adhere with all requirements specified and indicated on the Drawings. The products will be reviewed and considered for acceptance provided all the requirements outlined in subsequent paragraphs a, b, c, d, and e herein are met, this will ensure a faster review and avoid unnecessary delays.

a. Manufacturers referenced have pre-qualified with the University and have representation, with qualified service and parts, within 125 miles of Los Alamos, New Mexico.

b. Manufacturers not referenced must have representation, with qualified service and parts, within 125 miles of Los Alamos, New Mexico. A letter from the manufacturer must accompany the submittal attesting to local representation and service capabilities.

1) After receipt of the letter, the submittal will be reviewed for compliance with the Contract Documents.

c. Verify the physical characteristics of the equipment prior to submitting, in particular the dimensions with reference for access to components requiring routine service.

d. Provide project specific coordination drawings to indicate the installation of the equipment and how it interfaces with other disciplines.

e. Changes required in any discipline, with all costs incurred, due to equipment utilized other than the "Basis of Design" manufacturer is the sole responsibility of the contractor.

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01330 and 01700.

1. Materials/Parts List/Design Mixes (ML): Provide a list of equipment manufacturers within 15 calendar days of the award of the General Contract. Include the following:

a. The lead time required for delivery.

b. This procedure will facilitate the final review of submittals and expedite the approval procedure.

2. Binder: Provide a binder for the filing of the catalog data and shop drawing documents provided in the Mechanical submittals.

B. Any delays in construction, due to numerous resubmittals, are the responsibility of the contractor.

1.4 QUALIFICATIONS

A. Provide skilled mechanics in their respective trades.

B. Provide certified welders in accordance with the ASME Boiler Test Code, Section IX, latest edition.

1.5 HAZARDOUS CONDITIONS

A. Take precautions against hazardous construction conditions at all times during construction.

B. Cut back and protect protruding metal (bolts, steel angles) potentially hazardous to maintenance and operation personnel to reduce the risk of injury. Protect all openings between levels with barriers and gratings across the openings or steel bars through the openings to protect against injury.

1.6 MOTORS

A. See Section 15170.

PART 2 PRODUCTS

2.1 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 7500' above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.2 MANUFACTURER'S

A. Refer to subsequent sections herein.

PART 3 EXECUTION

3.1 DRAWINGS

A. The mechanical drawings show the general arrangement of all piping, and equipment. Follow as closely as actual building construction and work of other trades will permit. Investigate the structural and finish conditions affecting the Work and arrange work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions.

3.2 FIELD COORDINATION AND INSTALLATION PRIORITY

A. Carefully coordinate the installation of equipment and systems.

3.3 EQUIPMENT SUPPORT

A. Furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment and piping. Insure that the devices and supports are adequate as intended and do not overload the structural components in any way.

3.4 PROTECTION OF MATERIALS AND EQUIPMENT

A. Close pipe openings with caps or plugs to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, clean equipment and materials thoroughly and deliver in a satisfactory condition.

3.5 LUBRICATION

A. Protect all bearings and shafts during installation and thoroughly grease steel shafts to prevent corrosion.

3.6 INTERRUPTING SERVICES

A. Coordinate the installation of all work on the site in order to minimize interference with the operation of fire protection system. Carefully coordinate connections to existing systems requiring the interruption of service with the Contract Administrator to minimize system downtime. Connections to existing utilities will be performed by the University using materials supplied by the Contractor. Submit requests for the interruption of existing services to the Contract Administrator in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written approval of the Contract Administrator.

END OF SECTION

SECTION 15130

HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following pump:

B. Centrifugal, end suction, self priming de-watering pump with 3" suction and 3" discharge connections. Pump is supplied with oil bath mechanical seal, providing sufficient lubrication to allow dry running of the pump when it is not primed. A vacuum assist assembly provides lift capability. Conditions: 65GPM, 45 Ft. Head.

| Pump specification | Materials of construction |
|---|---|
| Casing components | Gray cast iron (Grade 14 to BS 1452) |
| Suction T piece | Gray cast iron (Grade 17 to BS 1452) |
| Non-return valve | Cast iron ASTM A126 Cl. B |
| Impeller and impeller wear plates | Gray cast iron (Grade 17 to BS 1452) |
| Shaft | EN-56 Stainless Steel (to BS 970) |
| Mechanical Seal | 316 stainless steel housing, Buna Nitrile bellows, Silicone carbide to carbon mating faces |

1.2 RELATED SECTIONS

A. Related Sections include the following:

1. Section 15050 - Basic Mechanical Materials and Methods.

2. Section 15170 - Motors.

1.3 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01330:

1. Catalog Data (CD): Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; operation and maintenance data, materials and spare parts list, installation instructions, and accessories for each type of product indicated. Indicate pump's operating point on curve.

1.4 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Power Prime Pumps

1. Power Prime Pump Model # DV-80-E, size 3”x3”, 1750 RPM, 7.5 HP, Electrical power requirements 460v, 3ph, 60Hz. Conditions: 65GPM, 45 Ft. Head.

2.2 GENERAL PUMP REQUIREMENTS

A. Pump described in this section shall be able to pump liquids including water, and slurries in accordance with standards as set forth by the Hydraulic Institute ANSI/HI 1.6-1994. (Subsections 4-10).

B. Motors: Include built-in, thermal-overload protection. Select motor to be non-overloading over full range of pump performance curve. Motors are to be rated for 7500 ft. elevation.

C. Motors indicated to be energy efficient: Minimum efficiency as indicated according to IEEE 112, Test Method B. Include motors with higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B, if efficiency is not indicated.

D. Electric motor is a 7-1/2 HP 1750 RPM (nom.) totally enclosed fan cooled, 3 phase, 460V motor on a size 213T frame. The motor is to have cast iron case with Class F insulation, class B rise at full load, and 40°C ambient continuous duty. The motor is to be designed for use in facilities requiring protection within harsh operating conditions.

E. Square D or equivalent pump control panel is to be 7-1/2 HP 480 volt full voltage start with heavy duty magnetic motor starter with fusible or circuit breaker type disconnect. Overload relays are ambient compensated, Quick-trip class 10 with adjustable current setting and phase loss protection. An oil-tight HAND-OFF-AUTO selector switch and START push button are provided. The panel is also equipped with a 480 to 120 volt transformer to provide power to an hour meter and potential add-on controls, and phase reversal protection. A through the door disconnect operating handle with provision for padlocks is standard. The enclosure is a rain resistant UL Type 3R with heavy duty steel construction suitable for outdoor use. The panel is to be supplied loose for remote mounting.

F. The pumping unit shall be equipped with a fully automatic priming system which includes a twin cylinder air compressor, stainless steel air ejector venturi assembly and an air-water separation tank. The pump shall be able to prime itself without the addition of water to the pump case. The venturi shall operate on the compressed air supplied from the compressor. The installation of a ball valve below the priming head assembly shall prevent the possibility of water induction into the compressor. The pump assembly shall have the ability to run absolutely dry for extended time periods.

G. The pumping unit shall not use a mechanical vacuum pump or require the use of a foot valve on the suction line. There shall be no protective float gear required. The pumping unit shall be demonstrated to have the ability to cycle repeatedly from a primed to an unprimed “SNORE” (No water present, unit running dry) condition.

H. The electric motor-pump assembly shall be coupled and mounted on a fabricated steel baseplate.

I. The pump assembly shall be capable of static suction lifts up to 28 feet vertically at sea level, and shall require no external adjustments to the priming system. Extended length suction lines may also be used.

J. Equipment acceptance is contingent upon its ability to operate in accordance with standards for centrifugal pump testing as set forth by the Hydraulic Institute ANSI/HI 1.6-1994 in addition to operating in a completely dry suction condition for extended periods of time.

K. Pump shall be equipped with a swing check non-return valve (NRV) on pump discharge. The NRV discharge flange shall be oriented at 45?. The non-return valve shall prevent backflow through the pump volute and allow for a vacuum-tight seal during priming. Standard construction shall be gray cast iron body with a grade C4 neoprene flapper (with bonded cast iron weight) on an EN-56 stainless steel seat.

L. The impeller shall be of Non-Clog, open design with pump-out vanes on the backside shroud to reduce pressure in the mechanical seal area. The impeller shall be 3 bladed of grade 17 gray cast iron material (BS 1452).

M. Front and rear wear plates shall be gray cast iron (to BS 1425) and shall be fully replaceable. Clearances between impeller faces and wear plates shall be attained through stainless shim gaskets and shall not affect pump priming ability.

N. Pump shafts shall be machined from EN-56AMR stainless steel (to BS 970). Bearing housings shall hold two ball bearing assemblies, running in an oil bath.

O. Seals shall be mechanical self adjusting with silicon carbide vs. carbon faces. The seal shall be secured within an oil reservoir housing to provide cooling and lubrication. The seal and housing requires no external adjustment or maintenance. Pump shall have continuous run-dry capability without damage for extended periods of time. Seal construction is stainless steel cage with Buna-N (Nitrile) elastomers as standard.

P. Pump and motor are to be coupled together using a flexible element shaft to shaft flanged coupling of suitable size. Shafts will be aligned to within 0.005” using a dial indicator.

Q. Electrical wiring is to be installed using flexible weather-tite conduit and connectors running from the power pump panel to the electric motor junction box.

R. The assembled pump, motor and panel are to be mounted on a fabricated skid constructed of structural steel providing suitable support for all components. The skid is to include a lift bail and a minimum of four openings for anchor bolts.

S. Completed assembly of pump, motor and skid base shall receive a primer base coat, allowed to dry prior to application of finish paint coats. Primer shall be an organic zinc primer. Paint shall be glossy acrylic enamel.

T. Material preparation and application of prime and finish paint coats to meet WOSCO Carbon Steel Equipment Coating Specification 101009.

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Install pumps according to manufacturer's written instructions.

1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. The authorized pump manufacturer’s representative shall instruct the end users in the proper installation, set up, operation and maintenance of the completed pumping units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Electrical power and control wiring and connections are specified in Division 16 Sections.

C. Ground equipment;

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Install each pump base in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 15170

MOTORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single phase electric motors up to 3/4 horsepower

B. 3-phase electric motors up to 200 horsepower

1.2 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01330, Submittals:

1. Certification that motors meet specified performance and efficiency requirements.

2. Catalog data showing compliance with specified requirements.

3. Wiring diagrams with electrical characteristics and connection requirements.

4. Test reports verifying guaranteed minimum efficiency for 3-phase motors 1 horsepower and larger.

5. Installation instructions including handling, storage, setting, mechanical connections, lubrication, wiring, and testing.

6. Operation and maintenance data

a. Operation data including instructions for safe operating procedures.

b. Maintenance data including assembly drawings, bearing data with replacement sizes, and lubrication instructions.

7. Project record documents:

a. Report of field tests showing compliance with Part 3 of this specification section.

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 - National Electrical Code.

B. Furnish products listed and labeled by Underwriters Laboratories, Inc., as suitable for purposes specified and shown.

1.4 SERVICE CONDITIONS

A. Provide motors capable of performing satisfactorily in the following service conditions:

1. Altitude of 7500 feet above sea level

2. Maximum ambient temperature of 104 degrees F, 40 degrees C

3. Minimum ambient temperature of minus 20 degrees F

4. 24-hour average temperature not exceeding 86 degrees F

5. Maximum solar heat gain: 110 Watts per square foot

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

A. General Electric

B. MagneTec

C. Baldor

### 2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors less than 250 Watts for general applications may be equipment manufacturer's standard product and need not conform to these specifications.

B. Provide motors with electrical and mechanical performance and characteristics in accordance with NEMA MG-1, Motors and Generators, unless specified otherwise in this Section.

C. Electrical Service:

1. 3/4 horsepower and smaller, furnish 115 volts, single phase, 60 Hz motors.

2. Greater than 3/4 horsepower, furnish 460 volts, 3-phase, 60 Hz motors.

D. Enclosure

1. Provide totally enclosed severe duty type motors.

E. Rating

1. Furnish motors that are rated on a continuous-duty basis. The output rating shall be available at the shaft at the specified speed, frequency, and voltage.

2. Provide motors that have been de-rated for 7500 feet altitude in accordance with NEMA MG-1. Do not use motor service factor to compensate for altitude. Refer to selection table below.

3. Provide motors designed for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

4. 1 horsepower and larger, furnish Premium Energy-Efficient Type motors.

F. Nameplates

1. Provide stainless steel nameplate on each motor indicating information required by ANSI/NFPA 70 and section 10.40 of NEMA MG-1.

2. Additional nameplate information may be required by other articles in this Section.

3. Attach nameplates to motor frame with stainless steel fasteners.

G. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

3. Provide a frame grounding screw or lug inside terminal cover or terminal box.

H. Furnish motors that meet NEMA MG-1-12.49 noise level standards.

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Provide single-phase power, split phase motors for applications less than 1/4 brake horsepower.

B. Furnish split phase motors that have the following characteristics:

1. Starting Torque: Less than 150 percent of full load torque

2. Starting Current: Up to 7 times full load current

3. Breakdown Torque: Approximately 200 percent of full load torque

4. Insulation: Class A (50 degrees C temperature rise)

5. Service Factor: Minimum of 1.35 for drip proof motors and 1.0 for enclosed motors

6. Bearings: Pre-lubricated ball bearings

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Provide single-phase power, permanent split capacitor motors for shaft mounted fans or blowers 3/4 brake horsepower and smaller.

B. Permanent split capacitor motors shall have the following characteristics:

1. Starting Torque: Exceeding 1/4 of full load torque

2. Starting Current: Up to 6 times full load current

3. Multiple Speed: Through tapped windings

4. Insulation: Class A (50 degrees C temperature rise)

5. Service Factor: 1.0

6. Bearings: Pre-lubricated ball or sleeve bearings

7. Integral Protection: Automatic reset overload protector

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Provide single-phase power, capacitor start motors for applications 1/4 brake horsepower through 3/4 brake horsepower.

B. Furnish capacitor start motors that have the following characteristics:

1. Starting Torque: 3 times full load torque

2. Starting Current: Less than 5 times full load current

3. Pull-up Torque: Up to 350 percent of full load torque

4. Breakdown Torque: Approximately 250 percent of full load torque

5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with 2 capacitors in parallel with run capacitor remaining in circuit at operating speeds

6. Insulation: Class A (50 degrees C temperature rise)

7. Service Factor: Minimum of 1.25 for drip proof motors and 1.0 for enclosed motors

8. Bearings: Pre-lubricated ball bearings

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Provide 3-phase power, squirrel cage motors for applications more than 3/4 brake horsepower

B. Furnish 3-phase power, squirrel cage motors that have the following characteristics:

1. Starting Torque: NEMA Design B characteristics

2. Starting Current: NEMA designation G, six times full load current

3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics

4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors

5. Insulation System: NEMA Class F or better

6. Service Factor: 1.15 minimum

7. Sound Power Levels: To NEMA MG 1

C. Test motors in accordance with NEMA MG-1-12 and IEEE 112, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators. Each motor shall receive a routine commercial test to verify freedom from electrical or mechanical defects. Provide prototype test reports for each rating.

D. Provide NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

E. For motor Frame Sizes 254T and larger provide three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.

F. Provide grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum ANSI/AFBMA 9 - Load Ratings and

Fatigue Life for Ball Bearings, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp ANSI/AFBMA bearing identification number on motor nameplate.

G. For floor-mounted belted applications, provide an adjustable sliding base; for applications above 10 horsepower, sliding base shall have 2 adjusting bolts.

H. Provide three phase motors having a minimum guaranteed full-load efficiency not less than that tabulated below when tested in accordance with IEEE Std. 112, subclause 6.4, Method B. Motor nameplates shall indicate guaranteed minimum full-load efficiency. Provide motors with nameplate horsepower matched to shaft load as tabulated below; this is to compensate for operating altitude and to include an engineering safety factor.

| MINIMUM FULL LOAD EFFICIENCY AND MAXIMUM LOAD | | | | | | | |
|---|---|---|---|---|---|---|---|
| MOTOR NAME-PLATE HP | NUMBER OF POLES SYNCHRONOUS SPEED, RPM | | | | | | MAXIMUM SHAFT LOAD (BHP) (DERATED TO 7500 FT ALTITUDE PLUS 10% SAFETY FACTOR ) |
| | OPEN MOTORS | | | ENCLOSED MOTORS | | | |
| | 2 3600 | 4 1800 | 6 1200 | 2 3600 | 4 1800 | 6 1200 | |
| 1 | -- | 82.5 | 80.0 | 75.5 | 82.5 | 80.0 | 0.78 |
| 1.5 | 82.5 | 84.0 | 84.0 | 82.5 | 84.0 | 85.5 | 1.17 |
| 2 | 84.0 | 84.0 | 85.5 | 84.0 | 84.0 | 86.5 | 1.56 |
| 3 | 84.0 | 86.5 | 86.5 | 85.5 | 87.5 | 87.5 | 2.35 |
| 5 | 85.5 | 87.5 | 87.5 | 87.5 | 87.5 | 87.5 | 3.91 |
| 7.5 | 87.5 | 88.5 | 88.5 | 88.5 | 89.5 | 89.5 | 5.86 |
| 10 | 88.5 | 89.5 | 90.2 | 89.5 | 89.5 | 89.5 | 7.82 |
| 15 | 89.5 | 91.0 | 90.2 | 90.2 | 91.0 | 90.2 | 11.73 |
| 20 | 90.2 | 91.0 | 91.0 | 90.2 | 91.0 | 90.2 | 15.63 |
| 25 | 91.0 | 91.7 | 91.7 | 91.0 | 92.4 | 91.7 | 19.54 |
| 30 | 91.0 | 92.4 | 92.4 | 91.0 | 92.4 | 91.7 | 23.45 |
| 40 | 91.7 | 93.0 | 93.0 | 91.7 | 93.0 | 93.0 | 31.27 |
| 50 | 92.0 | 93.0 | 93.0 | 92.4 | 93.0 | 93.0 | 39.08 |
| 60 | 92.9 | 93.6 | 93.6 | 93.0 | 93.6 | 93.6 | 46.90 |
| 75 | 93.0 | 94.1 | 93.6 | 93.0 | 94.1 | 93.6 | 58.63 |
| 100 | 93.0 | 94.1 | 94.1 | 93.6 | 94.5 | 94.1 | 78.17 |
| 125 | 93.6 | 94.5 | 94.1 | 94.5 | 94.5 | 94.1 | 97.71 |
| 150 | 93.6 | 95.0 | 94.5 | 94.1 | 95.0 | 95.0 | 117.25 |
| 200 | 94.3 | 95.0 | 94.5 | 94.5 | 95.0 | 95.0 | 156.34 |

PART 3 EXECUTION

3.1 INSTALLATION

A. Install motors and accessories in accordance with manufacturer's instructions.

B. Install motor securely on firm, level foundation.

C. Verify that line voltage and phase agrees with motor nameplate.

D. Make electrical connections to motors using materials and methods specified in Sections 16111, Conduit, and 16120, Building Wire and Cable.

E. Ground motors using materials and methods specified in Section 16450, Secondary Grounding.

3.2 FIELD ADJUSTMENTS

A. Lubricate motor in accordance with manufacturer's instructions.

B. Turn motor shaft by hand to ensure free rotation.

C. Verify that the area around motor fan cooling air inlets is free of debris that could be drawn into motor or motor fan during operation.

D. Check external bolted connections for proper torque.

3.3 FIELD TESTS

A. For motors 1 horsepower and larger, perform insulation resistance test of the stator windings in accordance with ANSI/IEEE Std. 43, IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery, and the motor manufacturer's instructions. Test duration shall be 1 minute. Tabulate resistances at 30 and 60 seconds and calculate the dielectric absorption ratio. Immediately notify Contract Administrator if motor insulation resistance is less than the following:

1. 460 volt motors: 100 megohms

Either replace motor or provide factory-trained manufacturer's service representative to inspect and test motor before making any further tests.

B. Make an initial uncoupled test of all motors in accordance with manufacturer's installation instructions. Verify proper direction of rotation and monitor bearings for excessive temperature, vibration, or noise. If abnormal noise or vibration is detected, immediately stop test and notify Contract Administrator. Either replace motor or provide a factory-trained manufacturer's service representative to inspect and test motor before making any further tests.

C. Make coupled start-up tests in accordance with manufacturer's installation instructions and as follows:

1. Measure and record motor starting time. Verify that it is less than manufacturer's rated stall time.

2. When motor is at full speed, observe motor for excessive vibration or noise.

3. Monitor bearing temperatures to verify proper lubrication.

4. Measure line current in each phase and verify balanced conditions.

END OF SECTION

SECTION 15180

HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe materials, fittings, valves, and accessories for cooling tower sump piping.

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01330, Submittal Procedures:

1. Catalog data on pipe materials, fittings, valves, and accessories.

2. Installation instructions for valves and accessories.

3. Certifications of welders.

1.3 QUALITY ASSURANCE

A. Comply with ASME B31.9, Building Services Piping.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to Section 01630, Product Options and Substitutions.

2.2 FLEXIBLE HOSE AND COUPLINGS

A. Manufacturer: Seal Fast Inc.

B. Materials: Goodyear hose.

1. Hose: Size 3” Goodyear Black EDM rubber with green stripe. Temperature range, -31 deg. F to 158 deg. F., Rated working pressure is 100 psi, vacuum rating 29 Hg. Reinforcement is 2 ply polyester tire cord steel helix wire. Cover is black EPDM rubber, weather and ozone resistant.

2. Cam and Groove Couplings, Clamps and Fittings: Provide Seal Fast Inc. aluminum couplings, clamps, adaptors, and fittings. All necessary components are to be provided for a complete system.

2.3 SUMP SUCTION/DISCHARGE WATER PIPING (STAND PIPES)

A. Pipe: Black steel, ASTM A53, standard wall.

1. Fittings: Black steel, ASTM A234, butt welded type, standard wall or malleable threaded type, ASME B16.3.

2. Joints: Welded for pipe size 2 1/2 in. and above, threaded for pipe sizes up to 2 in.

2.4 UNIONS, FLANGES, AND COUPLINGS

A. Unions for pipe 2 inches and under.

1. Ferrous Piping: ASME B16.39, Class 150, malleable iron treaded

2. Gaskets: 1/16 inch thick preformed neoprene.

B. Flanges for pipe over 2 inches.

1. Ferrous Piping: Forged Steel, ASME B16.5, Class 150.

2. Gaskets: 1/16 inch thick preformed neoprene.

C. Cam and Grove Couplings, Clamps, Adaptors and Fittings.

1. Provide Seal Fast Inc. aluminum couplings, clamps, adaptors, and fittings. All necessary components are to be provided for a complete system.

2.5 Valves

A. Gates Valves up to 2 inches.

1. Manufacturer: Nibco, Series 111.

2. MSS SP-80, Class 125, bronze body, bronze trim, rising stem, hand wheel, inside screw, solid wedge disc, solder or threaded ends.

B. Butterfly Valves over 2 inches.

1. Manufacturer: Nibco, Series LD 1000.

2. MSS SP-67, 200 psi non-shock cold water, ductile iron body, aluminum bronze disc, resilient replaceable EPDM seat, lug style, extended neck, gear operated, for use between Class 125/150 flanges. Provide 96” valve stem extension for 24” valves. Extension is to be suitable for use under water. Exact length of valve stem extension to be verified in field.

2.6 Strainers Screens

A. Strainer Screens

1. Manufacturer: Process Strainers Inc.

2. Stainless strainer screens with minimum 1/2” perforations for installation on sump drain/discharge standpipe pipe and flexible rubber hose extension.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

3.2 INSTALLATION

A. Install tower water piping in conformance with ASME B31.9.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals. Matching of bronze fittings with steel or copper pipe does not require dielectrics.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to neither interfere with use of space nor take more space than necessary.

E. Provide access where valves and other equipment are not exposed.

F. Install valves with stems upright or horizontal, not inverted.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals

2. Coordination Drawings

3. Record Documents

4. Maintenance Manuals

5. Rough-Ins

6. Electrical Installations

7. Cutting and Patching

1.3 CODES AND PERMITS

A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition and the Uniform Building Code, Latest Edition as adopted and interpreted by the LANL, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Contracting Officer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

1.4 RECORD DRAWINGS

A. See Division 1, Section 01720 for requirements associated with Project Record Drawings.

1.5 QUALIFICATIONS

A. All electricians shall be skilled in their respective trade.

1.6 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.7 DEFINITIONS

A. Definitions of terms will be found in the National Electrical Code.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.8 SUBMITTALS

A. Refer to Table in Section 01330.

1.9 MAINTENANCE MANUALS

1. Prepare maintenance manuals for materials listed.

1.10 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do no scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Project Manager and Engineers.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Project Manager and Engineers shall interpret the drawings and the specifications. The Project Manager and Engineers' interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.

F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.11 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

C. Examples of similar equipment types include but are not limited to:

1. Circuit Breakers

2. Motor Starters

3. Disconnects

4. Fuses

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

PART 2 PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 7500 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.

PART 3 EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefor, shall be submitted by the Contractor to the Contracting Officer for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval of the Contracting Officer. All changes shall be marked on record drawings.

B. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).

C. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.3 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with all other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.

7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extend possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination

requirements conflict with individual system requirements, refer conflict to the Contracting Officer.

9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

11. Install access panel or doors where units are concealed behind finished surfaces.

12. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

B. Install items level, plumb and parallel, and perpendicular to the building.

3.4 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall submit to Contracting Officer any work, which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.5 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Contracting Officer that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PAINTING

A. All finish painting of electrical systems and equipment will be under "Painting", Section 09900, unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Contracting Officer.

3.7 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the electrical work to the building structure to prevent damage of equipment and systems due to seismic activity.

B. See Section 13085 for requirements for seismic supporting of electrical equipment and systems.

C. Provide seismic anchoring and supports to meet UBC Zone 2B requirements.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Contracting Officer.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Contracting Officer prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgement of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Contracting Officer.

3.9 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code".

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer’s printed application instructions applicable to products and applications indicated, except where more stringent requirements apply. Refer to Section 07900, “Joint Sealants”.

3.13 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Drawings. In addition to the requirements, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

    a. Remove and replace defective Work.

    b. Remove and replace Work not conforming to requirements of the Contract Documents.

    c. Install equipment and materials in existing structures.

    d. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

5. During cutting and patching operations, protect adjacent installations.

6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.14 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Contracting Officer who shall make such compromises as he deems necessary and desirable.

3.15 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.16 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of electrical equipment herein.

3.17 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.18 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION

DIVISION 16 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: ___

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitution?
YES ? NO ? If YES, explain:_____
_____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ? NO ?

3. List differences between proposed substitutions and specified item.

| Specified Item | Proposed Substitution |
|---|---|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

4. Does substitution affect Drawing dimensions? YES ? NO ?

5. What affect does substitution have on other trades?_____
_____

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ? NO ?
If YES, explain:_____
_____

7. Will substitution affect progress schedule? YES ? NO ?
If YES, explain:_____
_____

8. Will maintenance and service parts be locally available for substitution? YES ? NO ?
If YES, explain:_____
_____

9. Is substitution identical in appearance and function to specialized product? YES ? NO ?

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone:_____

| | | |
|---|---|---|
| Accepted_____ | Not Accepted _____ | Received Too Late ___ |
| By: _____ | Date:_____ | Remarks:_____ |

For Engineer's Use Only

SECTION 16111

CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conduit and fittings

1.2 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70—*National Electrical Code*.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purposes specified and shown.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to prevent damage.

B. Protect conduits from corrosion and entrance of debris.

C. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.1 INTERMEDIATE METAL CONDUIT AND FITTINGS

A. Furnish galvanized intermediate metal conduit (IMC) that conforms to the requirements of UL1242—*Intermediate Metal Conduit*, ANSI C80.6—*Intermediate Metal Conduit*, and NFPA 70, Article 345.

B. For intermediate metal conduit, furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that conform to the requirements of UL514B—*Fittings for Conduit and Outlet Boxes,* and ANSI/NEMA FB1—*Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*.

2.2 RIGID GALVANIZED STEEL CONDUIT AND FITTINGS

A. Furnish rigid galvanized steel conduit (RGS) that conforms to the requirements of UL6—Rigid Metal Electrical Conduit, ANSI C80.1—Rigid Steel Conduit, Zinc Coated, and NFPA 70, Article 346.

B. For rigid galvanized steel conduit, furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that conform to the requirements of UL514B and ANSI/NEMA FB1.

2.3 PLASTIC-COATED STEEL CONDUIT AND FITTINGS

A. Furnish PVC exterior coated, urethane interior coated, galvanized rigid steel conduit or intermediate metal conduit that conforms to the requirements of NEMA RN 1—*PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit*.

B. Provide factory-fabricated elbows for sizes 2 inches and larger.

C. For plastic-coated steel conduit, furnish 40 mil PVC exterior coated, urethane interior coated, zinc-plated, threaded, malleable iron fittings and conduit bodies that conform to the requirements of UL514B—*Fittings for Conduit and Outlet Boxes* and NEMA RN 1—*PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit*.

2.4 ELECTRICAL METALLIC TUBING AND FITTINGS

A. Furnish galvanized electrical metallic tubing (EMT) that conforms to the requirements of UL797—*Electrical Metallic Tubing*, ANSI C80.3, and NFPA-70, Article 348.

B. For EMT, furnish concrete-tight, zinc-plated steel or zinc-plated malleable iron fittings that conform to the requirements of UL514B—*Fittings for Conduit and Outlet Boxes,* and ANSI/NEMA FB1—*Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*. Furnish insulated throat connectors.

2.5 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Furnish galvanized steel flexible metal conduit that conforms to the requirements of UL1—Flexible Metal Electrical Conduit and NFPA-70, Article 350.

B. For flexible metal conduit, furnish zinc-plated malleable iron fittings that conform to the requirements of UL514B—Fittings for Conduit and Outlet Boxes, and ANSI/NEMA FB1—Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies. Furnish insulated throat connectors.

2.6 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

A. Furnish liquid-tight flexible metal conduit that conforms to the requirements of UL360—Liquid-Tight Flexible Steel Conduit, Electrical and NFPA-70, Article 351.

B. For liquid-tight flexible metal conduit, furnish zinc-plated malleable iron or zinc-plated steel liquid-tight fittings that conform to the requirements of UL514B—Fittings for Conduit and Outlet Boxes, and ANSI/NEMA FB1—Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies. Furnish insulated throat connectors.

2.7 INSULATING BUSHINGS

A. Provide UL-listed insulating bushings with 105ºC rated insulation.

B. Manufacturer includes O-Z/Gedney, Type IB.

2.8 GROUNDING BUSHINGS

A. Provide UL-listed, galvanized malleable iron, 150ºC rated insulated throat grounding bushings with lay-in type ground cable lugs.

B. Manufacturer includes O-Z/Gedney, Type BLG.

2.9 SMOKE AND FIRE STOP FITTINGS

A. Furnish UL-listed, 3-hour rated smoke and fire stop fittings designed for placement around rigid steel conduit, intermediate metal conduit or electrical metallic tubing passing through core-drilled or cast-in-place holes in concrete floors or walls.

B. Manufacturer includes O-Z/Gedney, Type CFS.

2.10 CONDUIT MEASURING TAPE

A. Furnish conduit measuring tape with permanently printed measurements in one-foot increments.

B. Manufacturer includes Greenlee “GR435."

PART 3 EXECUTION

3.1 EXAMINATION

Examine surfaces to receive conduits for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 GENERAL

A. Conduit termination points shown on the Drawings are in approximate locations unless dimensioned. Verify termination locations of conduits before rough-in.

B. Conduit routing is shown on the Drawings in approximate locations unless dimensioned. Coordinate routing of conduits with structure and with work of other trades. Route conduits as required for a complete wiring system.

C. Use minimum ¾-inch conduit except as follows:

1. ½-inch conduit may be used for 20 ampere lighting and general purpose receptacle branch circuits.

2. ½-inch conduit may be used for connections to control and instrument devices

3.3 CONDUIT SUPPORTS

A. Support conduit in accordance with the requirements of Section 16190, Electrical Supporting Devices.

B. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports

3.4 CONDUIT INSTALLATION

A. Install conduit and fittings according to NFPA 70 and the following wiring methods schedule:

1. Outdoors

a. Exposed: Use rigid galvanized steel conduit or intermediate metal conduit for exposed outdoor work.

b. Concealed: Use rigid galvanized steel conduit or intermediate metal conduit for concealed outdoor work. Do not use rigid galvanized steel conduit or intermediate metal conduit in direct contact with earth.

c. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Use liquidtight flexible metal conduit for connections to vibrating exterior equipment.

d. Corrosive Locations (including cooling towers): Use plastic-coated rigid steel conduit for work in corrosive exterior locations.

2. Indoors

a. Exposed Dry Locations: Use electrical metallic tubing (EMT), 2-inch trade size and smaller, for exposed indoor work where not subject to physical damage during or after installation. Use rigid galvanized steel conduit or intermediate metal conduit for exposed indoor work subject to physical damage.

b. Concealed Dry Locations: Use electrical metallic tubing, 2-inch trade size and smaller, rigid galvanized steel conduit or intermediate metal conduit for concealed indoor work.

c. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Use flexible metal conduit for connections to vibrating equipment in dry indoor locations. Use liquidtight flexible metal conduit for connections to vibrating equipment in wet or damp indoor locations and in mechanical rooms.

d. Damp or Wet Locations: Use rigid galvanized steel conduit or intermediate metal conduit for work in indoor wet or damp locations.

e. Corrosive Locations: Use plastic-coated rigid steel conduit or non-metallic conduit (PVC) for work in corrosive indoor locations.

B. Install exposed conduits parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked conduits together, on common supports where practical.

2. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

3. Use conduit bodies to make sharp changes in direction, as around beams.

4. Arrange conduits to maintain headroom.

C. Join and terminate conduits with fittings designed and approved for the purpose.

1. Make-up metallic fittings wrench tight.

2. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

3. Use insulating bushings or connectors with an insulated throat to protect conductors.

4. Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

5. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

6. Use threaded hubs or sealing locknuts to fasten conduits to boxes in exterior, damp or wet locations.

7. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduits dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

D. Stub-Up Connections

1. Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor or equipment pad.

2. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor.

3. Where equipment connections are not made under this Contract, install threaded flush plugs flush with the floor.

E. Flexible Connections

1. Connect equipment subject to vibration, noise transmission, or movement, and all motors using a minimum of 18 inches and maximum of 3 feet length flexible conduit.

F. Install plastic-coated rigid steel conduit and fittings according to NFPA 70 and manufacturer's instructions. Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

G. Maintain the following minimum inch clearances between conduit and surfaces with temperatures exceeding 104º F (40º C):

1. 3" at perpendicular crossings

2. 6" between parallel runs

H. Avoid moisture traps in conduit system; provide junction boxes with drain fitting at low points in conduit system.

I. Install expansion fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.

J. Use suitable caps to protect installed conduits against entrance of dirt and moisture.

K. Install grounding bushings at the following locations:

1. At every entry to enclosures on metallic conduits containing circuits rated 100 amperes and higher

2. On metallic conduits entering enclosures through concentric, eccentric or oversize knockouts

3. On metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings

4. Ground and bond conduits under provisions of Section 16450, Secondary Grounding

L. Install conduit measuring tape in empty raceways. Leave not less than 12 inches of slack at each end of the tape. Secure each end of tape.

3.5 FIRESTOP INSTALLATION

A. Install fire and smoke stop fittings at single electrical conduit penetrations through core-drilled openings in fire-rated concrete walls and floors. Install following manufacturer's instructions to restore original fire rating.

B. Install smoke and fire sealant caulk at conduit penetrations through openings in fire rated walls, floors and partitions. Install in accordance with manufacturer's instructions to restore original fire rating.

C. Request inspection of firestop installations by the LANL Authority Having Jurisdiction both before and after installation of firestop materials.

3.6 CONDUIT IDENTIFICATION

A. Mark and identify conduits as required in Section 16195, Electrical Identification.

END OF SECTION

SECTION 16120

BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Building wire and cable

B. Wire and cable connectors

C. Insulating tape and tubing

1.2 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70 - *National Electrical Code*.

B. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purposes specified and shown.

1.3 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required to meet project conditions.

PART 2 PRODUCTS

2.1 BUILDING WIRE AND CABLE

A. Provide UL-listed building wire and cable as shown on the Drawings with the following characteristics:

1. Description: Single conductor insulated wire

2. Conductor: 98% conductivity, annealed, uncoated copper

3. Conductor Stranding

a. Power conductors, No. 10 AWG and smaller, solid

b. Control conductors, No. 10 AWG and smaller, stranded

c. Conductors No. 8 AWG and larger, stranded

4. Insulation: The following types, rated 600 volts:

a. No. 2 AWG and smaller, Type THHN/THWN per UL Standard 83—*Thermoplastic Insulated Wires*

b. No. 1 AWG and larger, Type THHN/THWN per UL Standard 83 or Type XHHW per UL Standard 44—*Rubber Insulated Wires and Cables*

B. Color code conductors as follows:

1. Use colored insulation for color coding conductors No. 6 AWG and smaller.

2. Use water and oil resistant colored plastic adhesive tape, ¾-inch minimum width, for color coding conductor No. 4 AWG and larger.

Manufacturer: 3M "Scotch 35"

3. Provide black conductor insulation where colored tape is used for color coding.

4. Use the following color codes for AC power system conductors:

| | 208Y/120V System | 480Y/277V System |
|---|---|---|
| Phase A: | Black | Brown |
| Phase B: | Red | Orange |
| Phase C: | Blue | Yellow |
| Neutral: | White | White/Orange |
| Equipment Ground: | Green | Green |
| Isolated Ground: | Green/Yellow | Green/Yellow |

5. In existing facilities, change color coding of existing service, feeder, and major branch circuits (50 amps and larger) to match the above color code.

6. Provide color code for control conductors as indicated on equipment or control system manufacturer's drawings.

2.2 WIRING CONNECTORS

A. Provide solderless insulated, spring type connectors, rated 600 volts and 105 ºC for splices and taps for wire sizes No. 8 AWG and smaller.

Manufacturer: 3M "Scotchlock"

B. Provide tin-plated copper, mechanical type connectors that meet the requirements in UL Std. 486A for splices and taps for wire sizes No. 6 through No. 2 AWG.

Manufacturer: Burndy "SERVIT"

C. Provide circumferential compression connectors that meet the requirements in UL Std. 486A for wire sizes No. 1 AWG and larger. Lugs, splices, reducer adapters and tap connectors shall be manufactured from electro-tin plated seamless copper tubing and marked with cable accommodation, die codes and crimp locations.

Manufacturer: Burndy "HYLUG", "HYLINK", and "HYTEE"

D. Provide crimp-on, nylon insulated, insulation grip, brazed seam terminals for control wiring as follows:

1. Use ring tongue terminals for nutted studs.

Manufacturer: Burndy "Type TN"

2. Use flanged fork terminals for barrier terminal strips.

   Manufacturer: Burndy “type YAE-Z”

3. Use pin terminals for DIN type terminal blocks.

   Manufacturer: 3M type “MNG-P”

2.3 INSULATING TAPE AND TUBING

A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:

1. 7 mil minimum thickness

2. Rated 600 volts and 105 ºC, suitable for indoor and outdoor applications

3. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100 ºF without loss of physical or electrical properties

4. Resistant to abrasion, moisture, alkalies, acid, corrosion, and sunlight

5. Manufacturer: 3M “Scotch Super 33+”

B. Provide heat shrinkable tubing that meets the requirements of UL 486D and has the following characteristics:

1. Rated 1kV

2. Factory applied adhesive/sealant

3. Flame retardant to IEEE 383, *Vertical Tray Flame Test*

4. Manufacturer: Raychem “FCSM”

2.4 WIRE PULLING LUBRICANT

A. Provide wire pulling lubricant that is compatible with conductor insulation, has a maximum coefficient of friction of 0.055, and is stable up to a temperature of 180 ºF. For cold weather installations, provide wire pulling lubricant suitable for conduit temperature.

B. Manufacturer includes IDEAL “Yellow 190" or “Aqua-Gel CW.”

PART 3 EXECUTION

3.1 PREPARATION

A. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Remove existing wire from raceways before pulling in new wire and cable.

C. Completely and thoroughly swab raceways before installing wire.

D. Store cable for 24 hours in the installation area ambient temperature before installing.

3.2 INSTALLATION

A. Install products following manufacturer's instructions.

B. Use solid conductor for power circuits No. 10 AWG and smaller except use stranded conductors in flexible conduits.

C. Use stranded conductors for power circuits No. 8 AWG and larger.

D. Use stranded conductors for control circuits.

E. Use conductors not smaller than No. 12 AWG for power and lighting circuits.

F. Use conductors not smaller than No. 14 AWG for 120V control circuits.

G. Use conductors not smaller than No. 16 AWG for 24V control circuits.

H. Use No. 10 AWG conductors from panelboard to first outlet for 20 ampere, 120-volt branch circuits longer than 75 feet.

I. Use No. 10 AWG conductors from panelboard to first outlet for 20 ampere, 277-volt branch circuits longer than 150 feet.

J. Pull all conductors into a raceway at same time.

K. Do not "through-pull" conductors at boxes, fittings or cabinets where a change of raceway alignment occurs.

L. Use suitable wire pulling lubricant for installing building wire in raceways.

M. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

N. Neatly train and lace wiring inside boxes, equipment, and panelboards.

O. Install wiring at outlets with at least 6 inches of slack conductor at each outlet.

P. Clean conductor surfaces before installing lugs and connectors.

Q. Do not cut conductor strands to fit into connectors.

R. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

S. Terminate conductors No. 1 AWG and larger using compression connectors at the following locations: install using manufacturer's recommended compression tools and dies:

1. Circuit breakers larger than 100 amperes; at smaller circuit breakers use mechanical lugs

2. Safety switches larger than 100 amperes; at smaller safety switches use mechanical lugs

3. Transformers

4. Switchgear, switchboard, panelboard, busway and motor control center main lugs

T. Terminate control conductors using crimp-on terminals.

U. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

V. Insulate splices and taps of irregular shapes with manufactured insulating covers or vinyl tape built up to not less than the conductor insulation thickness.

W. Insulate cylinder shaped splices and taps, connector barrels and adapter barrels using heat shrinkable insulating tubing or insulating covers manufactured for the connector.

X. Apply color coding tape on conductors at each termination, splice, junction and pull box.

Y. Post conductor color code on each panelboard, switchboard, switchgear assembly, motor control center, dry-type transformer, safety switch and separate motor controller. Use type-written, adhesive-backed labels.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 16195, Electrical Identification.

3.4 FIELD QUALITY CONTROL

A. Upon installation of wires and cables and before electrical circuitry is energized, show product capability and compliance with requirements.

B. Perform the following visual and mechanical inspections in accordance with procedures in NETA ATS-1999:

1. Inspect wire for physical damage and proper connection according to the Drawings.

2. Measure tightness of mechanical connections and compare torque measurements with manufacturer's recommended values. Use a calibrated torque wrench.

3. Check for correct conductor color coding according to Specifications.

C. Perform the following electrical tests:

1. Test insulation resistance of each conductor with respect to ground and other conductors in the same raceway. Use a 1000Vdc megger; maintain test for 1 minute on each conductor.

2. Test continuity of each power circuit conductor.

3. Test continuity of each control circuit conductor.

4. Evaluate test results by comparison with conductors of the same length, size and insulation type. Investigate any values less than 50 megohms.

D. Correct malfunctioning products at the site, where possible, and retest to prove compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION

SECTION 16130

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet boxes

B. Junction and pull boxes

1.2 SUBMITTALS

A. Submit the following according to the provisions of Section 01330:

1. Catalog data for each type of product specified

1.3 QUALITY ASSURANCE

A. Conform to the requirements of NFPA 70, *National Electrical Code*.

B. Furnish products listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 PRODUCTS

2.1 COATINGS

A. Provide boxes protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

B. Provide products for use outdoors with either hot-dipped galvanized finish or zinc electroplate and aluminum polymer coating.

2.2 OUTLET BOXES

A. For dry locations provide galvanized steel outlet boxes that comply with UL Standard 514-A, ANSI/NEMA OS1, and NFPA 70 as to size and construction.

1. For surface outlet boxes in EMT raceway systems, use 4 inch x 2-1/8-inch deep square boxes. Provide deeper boxes or multiple gang boxes as required to fit devices. Provide square surface covers that match the installed device and have not less than two holes for securing the device to the cover.

2. For surface outlet boxes in rigid galvanized steel or IMC raceway systems, use 4-11/16 square, 2-11/16 inch deep cast malleable iron boxes with threaded hubs. Provide multiple gang boxes as required to fit devices. Provide gasketed cast malleable iron or cast copper-free aluminum covers that match the installed device and have not less than two holes for securing the device to the cover.

B. For damp or wet locations provide outlet boxes that comply with UL Standard 498 and 514, ANSI/NEMA FB1, and NFPA 70 as to size and construction. Outlet boxes in below-grade masonry or below-grade cast-in-place concrete walls are considered to be in damp locations.

1. For lighting fixture outlets use 4 inch x 2-1/16 inch deep round cast malleable iron boxes with threaded hubs.

2. For flush or surface wall-mounted outlets, use 4-11/16 square, 2-11/16-inch deep cast malleable iron boxes with threaded hubs. Provide multiple gang boxes as required to fit devices. Provide gasketed cast malleable iron or cast copper-free aluminum covers that match the installed device and have not less than two holes for securing the device to the cover.

2.3 PULL AND JUNCTION BOXES

A. For dry locations provide galvanized sheet steel pull and junction boxes that comply with UL Standard 50 Type 1 and NFPA 70 as to size and construction. Use boxes not less than 4 inches square x 1-1/2 inches deep with screw-secured covers. Provide larger boxes as required by the number and size of conduits and conductors.

B. For damp or wet locations, in conduit runs up to ¾-inch trade size, provide 4-11/16 square, 2-11/16-inch deep cast malleable iron boxes with threaded hubs and gasketed cast malleable iron or cast copper-free aluminum covers.

C. For pull and junction boxes in damp or wet locations in conduit runs 1-inch trade size and larger use galvanized sheet steel boxes that comply with UL 50 Type 3R and NFPA 70 as to size and construction.

D. Provide connection point for equipment grounding conductor in each pull and junction box.

2.4 SMOKE AND FIRE SEALANT

A. Refer to Section 07270, Firestopping, for smoke and fire sealant products.

B. Provide smoke sealant and fire barrier latex caulk that has intumescent and endothermic properties and has UL Classified system ratings of up to four hours.

C. Manufacturer includes 3M, type CP 25WB+ Caulk.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Electrical boxes are shown on the Drawings in approximate locations unless dimensioned. Verify final location of each outlet box by field measurements and coordination with other trades. Install each box at a location suitable to serve its intended purpose.

B. Install boxes level, plumb, and securely mounted.

C. Restore fire resistance rating of walls and ceiling assemblies penetrated by boxes.

1. Use smoke and fire sealant caulk. Install caulk following manufacturer's instructions to restore original fire rating.

2. Request inspection of fire stop installations by the LANL Authority Having Jurisdiction both before and after installation of fire stop materials.

D. Install knockout closures in unused box openings.

3.2 BOX SUPPORTS.

A. Rigidly attach boxes to the building structure.

B. Refer to Section 16190, Supporting Devices.

3.3 OUTLET BOX INSTALLATION

A. Where the Drawings show outlets as adjacent, align outlet boxes with each other.

B. Install a blank cover plate on each outlet box in which no device is installed.

3.4 PULL AND JUNCTION BOX INSTALLATION

A. Install pull and junction boxes as shown on the Drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Install pull and junction boxes in accessible locations. Position boxes so covers can be removed. Place boxes to maintain headroom. Locate pull boxes and junction boxes above accessible ceilings and in unfinished spaces.

C. Install cover on each box.

3.5 GROUNDING

A. Ground boxes as required in Section 16450, Secondary Grounding.

3.6 PROTECTION

A. Provide final protection and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at final inspection.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.7 CLEANING

A. Clean foreign matter from interior of boxes before installing wiring, devices, and covers.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Secure support for electrical items from the building structure by means of hangers, supports, anchors, concrete bases, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS

A. Submit the following in accordance with the provisions of Section 01330.

B. Catalog Data: Submit catalog data for each type of product specified. Include information substantiating equivalent corrosion resistance to zinc coated steel of alternative treatment, finish, or inherent material characteristic.

1.3 QUALITY ASSURANCE

A. Conform to the requirements of NFPA 70—*National Electrical Code*.

B. Where Underwriters Laboratories, Inc. has requirements for such products, furnish products listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 PRODUCTS

2.1 COATINGS

A. Provide supports, hardware, and fasteners protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

B. Provide products for use outdoors with hot-dip galvanized coating.

2.2 RACEWAY SUPPORTING DEVICES

A. Provide supports as described below for the complete installation of raceway systems.

B. Use pressed steel, single bolt hangers to support individual RGS, IMC, or EMT conduit runs from threaded rods or beam clamps.

Manufacturer: O-Z/Gedney "Type H-WBS"

C. For individual runs of EMT up to 1-inch trade size, use coated spring steel conduit clips with positive snap closure.

Manufacturer: ERICO CADDY "M Series"

D. Use malleable iron conduit clamps to secure RGS, IMC or EMT conduit runs across, parallel, or perpendicular to beams, channels and angle supports.

Manufacturer: O-Z/Gedney "Type UBC, UPC and UEC"

E. Use snap-on type one-hole steel straps to secure conduits up to 2 inch trade size to flat, dry interior surfaces.

Manufacturer: O-Z/Gedney "Type 14S Series" for RGS and IMC and "Type 15S Series" for EMT

F. Use two-hole steel straps to secure conduits 2-1/2 to 4 inch trade size to flat, dry interior surfaces.

Manufacturer: O-Z/Gedney "Type THR"

G. Use one-hole malleable iron straps and clamp backs to secure conduits to flat exterior or damp flat interior surfaces.

Manufacturer: Appleton "Type CL-M Series" with "Type CLB-M Series clamp backs"

## 2.3 FASTENERS

A. Provide fasteners of the types, materials, and construction features as follows:

1. Expansion Anchors: UL-listed carbon steel wedge type studs

   Manufacturer: Hilti "Kwik Bolt II"

2. Toggle Bolts: All steel spring head type

3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

4. Masonry Screw Anchors: Case hardened steel

   Manufacturer: Hilti "Kwik-Con II"

5. Beam Clamps: Malleable iron body with hardened set screw and threaded hole for threaded rod

   Manufacturer: O-Z/Gedney "Type IS"

6. Spring Tension Fasteners: Spring steel, designed specifically for the intended service

   Manufacturer: ERICO "CADDY"

## 2.4 FRAMING CHANNEL SYSTEMS

A. Provide U-channel framing systems using 12-gauge steel channels, with 9/16-inch-diameter holes, from 1-1/2 to 1-7/8 inches on center, in the surface opposite the "U" opening.

B. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer. Use two-piece, single bolt type conduit straps on U-channel supports.

C. Manufacturers include Unistrut, B-Line, and Superstrut.

## 2.5 FABRICATED SUPPORTING DEVICES

A. Provide shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Provide steel brackets fabricated from angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

2.6 SLEEVES AND SEALS

A. Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap-lock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:

a. 3-inch and smaller: 20-gauge

b. 4-inch to 6-inch: 16-gauge

c. over 6-inch: 14-gauge

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe two pipe sizes larger than the penetrating raceway.

3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe two pipe sizes larger than the penetrating raceway.

B. Provide factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, clamps, and cap screws.

Manufacturer: O-Z/Gedney "Type FSK"

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NFPA 70 requirements and manufacturer's recommendations.

B. Coordinate electrical supporting systems with the building structural system and with the work of other trades.

C. Conform to manufacturer's recommendations for selection and installation of supports and fasteners.

D. The strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.

E. Coat cut ends of shop or field fabricated supports with a rust-inhibiting finish compatible with the factory finish. Apply in accordance with manufacturer's instructions.

F. Do not use wire or perforated strap for electrical supports.

3.2 RACEWAY SUPPORTS.

A. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

B. Support three or more parallel runs of horizontal raceways together on trapeze hangers.

C. Support individual horizontal raceways by separate pipe hangers. Do not support conduits from ceiling suspension wires.

D. Space supports for raceways in accordance with NFPA 70.

E. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

F. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

G. Install vertical cable supports simultaneously with installation of conductors.

3.3 BOXES AND CABINETS

A. Support sheet metal boxes directly from the building structure or by approved brackets or bar hangers. Where bar hangers are used, attach the bar to structure on opposite sides of the box.

B. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support.

C. Install surface-mounted cabinets and panelboards with minimum of four anchors. In wet or damp locations, provide steel channel supports to stand cabinet one inch off wall.

D. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the specified structural safety factors. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

3.4 HANGER RODS

A. Use threaded hanger rods not less than the sizes scheduled below:

1. Individually hung conduits, ½ inch through 1¼ inch.....1/4 inch

2. Individually hung conduits, 1½ inch through 4 inch.....3/8 inch

3. Trapeze hung conduits, 10 foot maximum spacing.....3/8 inch

4. Trapeze hung conduits, 20 foot maximum spacing.....1/2 inch

B. Use hanger rods to support suspended equipment as indicated on the Drawings.

3.5 FASTENING

A. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following schedule:

| BUILDING MATERIAL | ELECTRICAL MATERIAL | FASTENER |
|---|---|---|
| Wood | Any | Wood screws. |
| Hollow masonry units | Any | Toggle bolts or masonry screw anchors. |
| Concrete or solid masonry | Any | Preset concrete inserts or expansion bolts. |
| Concrete or masonry | Cabinets, up to 2-inch conduit | Masonry screw anchors. |
| Concrete or masonry | Outlet boxes, ½- and ¾-inch conduit | Threaded studs driven by a powder charge and provided with lock washers and nuts. |
| Structural steel | Any | Beam clamps, machine screws, or welded threaded studs. |
| Structural steel, non-corrosive, indoor locations | Outlet boxes, ½- and ¾-inch EMT | Spring tension fasteners. |
| Sheet metal | Any | Sheet metal screws. |
| Metal studs | Outlet boxes, ½- and ¾-inch EMT | Spring tension fasteners, sheet metal screws. |
| Acoustical ceiling T-bars | Outlet boxes, ½- & ¾-inch EMT | Spring tension fasteners, sheet metal screws |

B. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill unused holes.

C. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

E. Install fasteners in accordance with manufacturer's instructions. Tighten fasteners to manufacturer's recommended torque.

3.6 SLEEVES AND SEALS

A. Install sleeves in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables. Follow manufacturer's instructions to restore original fire rating of wall or slab.

B. Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

C. Request inspection of firestop installations by the LANL Authority Having Jurisdiction both before and after installation of firestop materials.

3.7 TESTS

A. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors

2. Toggle bolts

3. Powder-driven threaded studs

4. Masonry screw anchors

B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SECTION INCLUDES

Furnish and install electrical identification in accordance with the requirements of this Section and as indicated on the Drawings:

A. Equipment code tags to identify each piece of electrical equipment

B. Nameplates of the following three categories:

1. Category I, Circuit Directory Information

Nameplates shall contain circuit number, piece of equipment being served or being served from, location of equipment served or being served from, voltage, number of phases, and number of wires.

2. Category II, General or Operational Information

Nameplates shall contain basic instructions or specific operating procedures such as special switching procedures for a load transfer scheme.

3. Category III, Emergency Operations

Nameplate shall contain information concerning emergency shutdown procedures for room, equipment, and building isolation in event of fire or other emergency.

4. Label on each light switch and receptacle outlet indicating circuit number, panelboard and voltage

5. Wire markers on power, control, and communication circuit wires

6. Voltage markers on switchgear, panelboards, motor control centers, safety switches, and conduits

7. Warning signs on transformers, switchgear, panelboards, motor control centers, and safety switches

8. Marking of NFPA 70 required clear working space at electrical equipment

9. Underground warning tape above underground conduits

10. Identification signs for emergency system components

PART 2 PRODUCTS

2.1 EQUIPMENT CODE TAGS

A. Furnish equipment code tags as specified below with lettering as scheduled on the Drawings.

B. Coordinate equipment code tag schedule with equipment numbering scheme provided by Contract Administrator.

C. Provide code tags with black letters on yellow background with 2 in. by 3 in. dimensions.

D. Provide lettering as follows:

1. Size: 48 point

2. Spacing

a. 1/4 inch from top and bottom

b. 1/2 inch between lines

E. Provide tags made of one of the following materials:

1. Type 1 (Indoor Applications Only)

a. Plastic adhesive tape with dry transfer letters covered with protective coating of clear plastic spray

b. Manufacturer includes 3M "Scotchcal", No. 3485 Saturn Yellow.

2. Type 2

a. Two-ply plastic nameplate with letters engraved through yellow surface showing black core.

b. Provide UV stabilized material for outdoor applications.

c. Manufacturer includes Seton Nameplate Corp., "Setonply" for indoor applications, and "Setonflex" for outdoor applications.

2.2 EQUIPMENT NAMEPLATES

A. Furnish equipment nameplates as specified below with lettering as scheduled on the Drawings.

B. Coordinate equipment nameplate schedule with equipment numbering scheme provided by Contract Administrator.

C. Provide nameplates made of one of the following materials:

1. Type 1 (Indoor Applications Only)

a. Vinyl plastic with photo-processed typewritten letters.

b. Manufacturer includes Thomas & Betts, Vinyl E-Z-Code Special Markers.

2. Type 2

a. Two-ply plates with letters engraved through surface color showing core color.

b. Use UV stabilized material for outdoor applications.

c. Manufacturer includes Seton Nameplate Corp., "Setonply" for indoor applications, "Setonflex" for outdoor applications.

D. Provide lettering as follows:

1. Size: 10 point minimum

2. Spacing

a. 1/4 inch from top

b. 1/8 inch from bottom

c. 1/16 inch between lines

E. Provide colors as follows:

1. Category I nameplates: White letters on blue background

2. Category II nameplates: White letters on black background

3. Category III nameplates: White letters on red background

F. Dimensions shall be as follows:

1. Category I nameplates: 1 3/16 inch by 2½-inch minimum

2. Category II nameplates: As required for instructions

3. Category III nameplates: As required for emergency instructions

2.3 WIRE MARKERS

A. Provide wire markers for power, control, instrumentation, alarm and communication circuit wires.

B. Furnish split sleeve or self-laminating adhesive type wire markers.

C. Locate a wire marker on each conductor at switchgear, panelboards, pull boxes, outlet and junction boxes, and each load connection.

D. Provide lettering on wire markers as follows:

1. Power and Lighting Circuits: As-built branch circuit or feeder circuit number

2. Control Circuits

As-built control wire number indicated on schematic and interconnection diagrams on Drawings or equipment manufacturer's wiring diagrams.

E. Manufacturer includes LEM Products, Inc, Model "Snap-On Markers", "SLWT" or "SLTS" self-laminating adhesive markers.

2.4 VOLTAGE MARKERS

A. Furnish voltage markers for transformers, conduits, switchgear, panelboards, motor control centers, safety switches, pull boxes, and cabinets.

B. Provide flexible pressure sensitive vinyl voltage markers that conform to OSHA regulations.

C. Provide voltage markers with 9 inch x 2¼-inch orange background and black letters. Comply with OSHA regulations.

D. Provide voltage markers with lettering as follows:

1. 480 Volt System: 480 VOLTS

2. 208 Volt System: 208 VOLTS

3. 15kV System: 13200 VOLTS

4. Fire Alarm System: FIRE ALARM

5. Telephone/Data System: TELEPHONE

E. Manufacturer includes LEM Products, Inc, Model LVM.

2.5 WARNING SIGNS

A. Furnish warning signs for transformers, switchgear, panelboards, motor starters, motor control centers, safety switches and pull boxes.

B. Use flexible warning signs that conform to OSHA Danger and Caution specifications.

C. Provide minimum 10 inches x 7 inches warning signs.

D. Provide warning signs with lettering as follows:

1. Low Voltage Systems: "DANGER - UNAUTHORIZED PERSONS KEEP OUT"

2. Systems over 600 Volts: "DANGER - HIGH VOLTAGE - KEEP OUT"

E. Materials

1. For indoor applications use flexible, pressure sensitive, vinyl signs.

2. For outdoor applications use signs that are silk screened on O.060-inch thick plastic and overcoated with UV resistant plastic film.

F. Manufacturer includes Seaton Name Plate Co, Style No. 259-PSPL and 265S-PSPL (indoors), FSS16 and FSS10 (outdoors).

2.6 ARC FLASH WARNING LABELS

A. Furnish arc flash and electrocution hazard warning labels for switchgear, transformers, panelboards, motor starters, motor control centers, safety switches, and other locations as required by the 2002 NEC.

B. Provide warning labels that comply with ANSI Z535.1, Z535.2, and Z535.4. Color in top part of sign shall be ANSI “safety orange”. All lettering on labels shall be black; red is used below to indicate application-specific information.

C. Provide labels that are printed on self-adhesive polyester with pressure-sensitive adhesive back and covered with a clear polyester film. Outdoor labels shall be suitable for a high-UV environment.

D. Label dimensions shall be approximately 4 inches high by 5 inches wide.

E. Provide labels similar in design to that below. Use a black, UV-resistant, permanent marker to legibly fill in the application-specific information indicated in the notes.


**Arc Flash and Shock Hazard.**
**Wear Appropriate PPE.**

Determine appropriate protective clothing and personal protective equipment (PPE) for the task from NFPA 70E.

| | |
|---|---|
| 48 inch [1] | Flash Hazard Boundary |
| 18 kA [2] | Short Circuit Current Available |
| 480 VAC [3] | Shock Hazard when Cover is Removed [4] |
| 42 inch [5] | Limited Approach Boundary |
| 12 inch [6] | Restricted Approach Boundary |
| 1 inch [7] | Prohibited Approach Boundary |

Equipment Identification Code: 030040-EP-PP-A [8]

Notes:

1. Flash hazard boundary per NFPA 70E-2000 section 2-1.3.3.2.

2. Available short circuit current (RMS symmetrical amperes) calculated in accordance with IEEE Std 141 and IEEE Std 242.

3. System phase-to-phase voltage.

4. Condition that exposes worker to electrical shock hazard.

5. Limited Approach Boundary from NFPA 70E-2000 Table 2-1.3.4 and nominal system phase-to-phase voltage.

6. Restricted Approach Boundary from NFPA 70E-2000 Table 2-1.3.4 and nominal system phase-to-phase voltage.

7. Prohibited Approach Boundary from NFPA 70E-2000 Table 2-1.3.4 and nominal system phase-to-phase voltage.

8. Equipment Identification Code determined in accordance with LEM Chapter 1.

2.7 FLOOR MARKING TAPE

A. Use white and black tape, in stripes or checkers, for marking NFPA 70 clear working space at electrical equipment.

B. Provide tape that is 2-inch wide pressure sensitive vinyl with a clear protective overlaminate.

C. Manufacturer includes Seaton Name Plate Co, Style No. WSB or WBC.

PART 3 EXECUTION

3.1 GENERAL

A. Verify electrical equipment designations with FSS-9 through the Contract Administrator.

B. Clean surface where tag, nameplate marker or label is to be placed, using solvent.

C. Use manufacturer's recommended adhesive for engraved tags and nameplates.

D. Place tag, nameplate, marker or label centered and level.

E. Before energizing equipment, install nameplates identifying the purpose of each disconnecting means.

3.2 INSTALLATION

A. Locate equipment code tags and nameplates as shown on Drawings. Install after electrical equipment designations have been approved by FSS-9.

B. Install outlet labels on switches and receptacle outlets after electrical equipment designations have been approved by FSS-9.

C. Install wire markers on power, control and communication conductors at panelboards, pull boxes, outlet boxes, junction boxes, switchgear and load connections. Position markers so they can be read from the front of the enclosure.

D. Install voltage markers at the following locations and position markers so they can be read from floor:

1. Front of each low-voltage transformer, switchboard, panelboard, motor control center, enclosed circuit breaker, safety switch and starter enclosure

2. Cover of each pull box or junction box containing medium-voltage or low-voltage conductors

3. Each 2 inch and larger conduit longer than 6 feet; space markers not more than 20 feet on center

4. Each busway or wireway longer than 6 feet; space markers not more than 20 feet on center

E. Install warning signs at the following locations and position signs so they can be read from floor:

1. Front of each low-voltage transformer, switchboard, panelboard, motor control center, enclosed circuit breaker, safety switch and starter enclosure

2. Cover of each pull box or junction box containing medium-voltage or low-voltage conductors

3. Each busway or wireway longer than 6 feet; space markers not more than 20 feet on center

F. Install 2-inch wide white/black floor marking tape spaced 6 inches apart on the floor at the following locations to indicate clear working space required by NFPA 70:

1. Front of each low-voltage transformer, switchboard, panelboard, motor control center, enclosed circuit breaker, safety switch and starter enclosure.

END OF SECTION

SECTION 16450

SECONDARY GROUNDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Circuit and System Grounding

B. Enclosure and Equipment Grounding System

1.2 SUBMITTALS

A. Submit the following in accordance with the requirements of Sections 01330.

1. Catalog Data: Submit catalog data for grounding conductors, grounding clamps, grounding bushings, grounding plates, grounding bars, chemical ground rods, exothermic weld materials, compression grounding connector materials, and signal reference grid materials.

2. Project Record Documents: Submit project record documents to include specified certifications and field test reports of installed grounding systems.

1.3 QUALITY ASSURANCE

Furnish and install grounding systems in accordance with NFPA 70 - *National Electrical Code* and this specification section.

PART 2 PRODUCTS

2.1 GROUNDING CONDUCTORS

A. Provide UL-listed THHN/THWN insulated copper wire.

B. Use solid grounding conductors No. 10 AWG and smaller where not subject to vibration or repeated flexing.

C. Use stranded grounding conductors for No. 8 AWG and larger.

D. Use stranded grounding conductors where subject to vibration or repeated flexing. Use stranded grounding conductors in flexible conduit at motor connections.

E. Color code grounding conductors as follows:

1. Equipment Ground

a. Conductors No. 6 AWG and smaller: Green colored insulation

b. Conductors No. 4 AWG and larger: Black colored insulation with ¾-inch wide band of water and oil-resistant green plastic adhesive tape

2.2 GROUND CONNECTORS

A. Provide UL-listed copper alloy connectors with silicon bronze hardware for making cable to pipe connections.

Manufacturers: Burndy, O.Z.

2.3 CONDUIT GROUNDING BUSHINGS

A. Provide UL-listed, galvanized malleable iron, 150 C rated insulated throat grounding bushings with lay-in type ground cable lugs.

Manufacturers: O.Z., Thomas & Betts

2.4 COMPRESSION GROUNDING CONNECTIONS

A. Provide UL-listed wrought copper connectors, terminals and splices for making compression grounding connections.

B. Furnish connectors that have been tested successfully according to the requirements of IEEE Std. 837 - *IEEE Standard for qualifying Permanent Connections Used in Substation Grounding*.

C. Provide hydraulic compression tools and dies that match the connectors.

D. Match connector and die size to material shapes and sizes to be joined.

E. Manufacturer includes Burndy.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with the requirements of NFPA 70, this section and the Drawings.

B. Do not use the grounding systems specified in this section for lightning protection grounding. A separate lightning protection grounding system is specified in Section 16670, Lightning Protection System. Bond the lightning protection ground to the main electrode system at the service entrance ground bar.

C. Clean contact surfaces to which ground connections are to be made. Remove non-conductive coatings such as paint, enamel, oxidation and oil film.

D. Use the following connection methods unless otherwise specified or indicated on the Drawings:

1. Use high strength silicon bronze bolts, nuts, flat washers, and toothed lockwashers for making bolted ground connections.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B. Use a calibrated torque wrench.

F. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.

G. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.

2. Make connections with clean bare metal at points of contact.

3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.

4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

3.2 ENCLOSURE AND EQUIPMENT GROUNDING

A. General: Provide permanent and effective equipment, enclosure, and raceway grounding in accordance with NFPA 70, Table 250-122 requirements and as further specified or shown on the Drawings.

B. Provide an equipment ground bar, separate from any neutral bar, in all switchgear, switchboards, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc., for grounding the enclosure and for connecting other equipment and raceway ground conductors. Make connections to the ground bar using mechanical lugs or compression lugs.

C. Make connections and couplings on metallic conduit systems wrench tight.

D. Grounding Bushings

1. Install grounding bushings on metallic conduit containing circuits rated 100 amperes and higher.

2. Install grounding bushings on metallic conduits entering enclosures through concentric, eccentric or oversize knockouts.

3. Install grounding bushings on metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings.

4. Bond conduit grounding bushing lug to the equipment ground bar or ground lug in switchgear, switchboards, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc. Size bonding jumpers in accordance with NFPA 70, Table 250-122.

E. Provide an insulated equipment grounding conductor for each feeder and branch circuit.

1. Install the grounding conductor within the common conduit or raceway with the related phase and neutral conductors and connect to the box or cabinet grounding terminal or grounding bus.

2. Size equipment ground conductor in accordance with NFPA 70, Table 250-122 or as shown on the Drawings.

F. In each 15- or 20-ampere branch circuit outlet box and junction box, install a green colored washer head grounding screw with a minimum No. 12 equipment grounding conductor pigtail.

G. Connect receptacle grounding terminals to the equipment ground system using minimum No. 12 AWG equipment grounding conductor. Do not use a "self-grounding" receptacle strap as the only equipment grounding path.

H. Connect ground lead of low voltage surge arrestor or transient voltage surge suppressor to the equipment ground bar of the protected switchgear, switchboard or panelboard. Make connections as short and straight as practical; follow manufacturer's instructions.

I. Bond raceways served from cable tray using conduit clamps or grounding bushings that are UL approved for the purpose.

J. Install an equipment grounding conductor in each cable tray; size conductor per NFPA 70, Table 250-122, but not smaller than #6 AWG. Bond grounding conductor to each cable tray section using UL Listed cable tray ground clamps. Connect grounding conductor to ground bus of each enclosure or equipment item served by the cable tray.

K. Provide busways with a separate, internal equipment ground bus bar. Install separate insulated equipment ground conductor from the ground bus in the switchgear, switchboard, or distribution panel to the equipment ground bar terminal on busway. Size conductor in accordance with NFPA 70, Table 250-122.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power Panelboards

B. Lighting and Appliance Panelboards

1.2 QUALITY ASSURANCE

A. Provide products specified in this Section that are UL listed and labeled.

B. Components and installation shall comply with NFPA 70—*National Electrical Code*.

C. Comply with NEMA PB1—*Panelboards*, and NEMA AB1 — *Circuit Breakers*

D. Comply with UL 67—*Panelboards*, UL 50—*Cabinets and Boxes*, and UL *489—Circuit Breakers*.

E. Comply with Federal Specification W-P-115C Type I, Class 1 — *Circuit Breaker Panelboards*.

F. Provide products suitable for operation at 7500 ft. altitude.

1.3 SUBMITTALS

Provide the following submittals according to the requirements of Section 01330:

A. Catalog data for each type panelboard, accessory item, and component specified.

B. Maintenance data for panelboard components, for inclusion in Operating and Maintenance Manual. Include instructions for testing circuit breakers.

C. Panel circuit directory cards for installation in panelboards. Submit final versions after load balancing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspect panelboards on delivery and report concealed damage to the carrier within their required time.

B. Handle panelboards carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store panelboards in a clean, dry environment. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.5 EXTRA MATERIALS

A. Furnish six spare keys of each type for panelboard cabinet locks.

B. Provide one spray can of touch-up paint that matches panelboard finish.

PART 2 PRODUCTS

2.1 PANELBOARDS, GENERAL REQUIREMENTS

A. Provide panelboard cabinets for flush or surface mounted as indicted on the Drawings.

1. Furnish NEMA Type 1 enclosures.

2. Cabinets shall be galvanized steel constructed according to UL 50 requirements. Zinc coated galvanealed steel is not acceptable.

3. NEMA 1 boxes shall have removable end walls.

B. Provide trim fronts that meet the strength and rigidity requirements of UL 50.

1. Fronts for surface-mounted panels shall be same dimensions as box.

2. Fronts for flush panels shall overlap boxes at least 1 inch.

3. Fronts shall have ANSI 49 medium gray enamel electro-deposited over cleaned, phosphatized steel.

4. For NEMA 1 panelboards, provide fronts with hinged trim construction having a piano hinge down one side. The front shall contain a smaller lockable door, which when open, shall provide access to all device handles and rating labels. The hinged front, when open, shall provide access to all conductors and wiring terminals. The panelboard door shall open by a single lockable latch; the entire hinged front trim shall open by removing screws.

5. Provide a metal panelboard directory frame mounted inside the panelboard door.

6. Provide cylindrical tumbler type locks. Provide sliding vault locks with 3-point latching for enclosures more than 48 inches high. Key all lock assemblies alike. Provide two (2) keys with each lock plus spares as required in the Extra Materials paragraph above.

C. Panelboard phase and neutral bus shall be copper. Panelboard bus current ratings shall be determined by heat-rise tests conducted according to UL 67.

D. Provide compression type lugs for 100 amperes and larger main, neutral and branch circuit lugs; smaller lugs shall be mechanical type.

E. Provide copper or aluminum equipment ground bus that is adequate for feeder and branch-circuit equipment ground conductors. Bond ground bus to box.

F. Panelboards having a main circuit breaker shall be UL listed for use as service entrance equipment.

G. Equip panelboards with mounting brackets, bus connections, and necessary appurtenances, for the future installation of circuit breakers in the “spaces” scheduled on the Drawings.

H. Provide panelboards having UL listed short circuit current ratings not less than the available fault current indicated on the Drawings. With the exception of panelboard with a current-limiting main circuit breaker, do not use “series ratings” for circuit breaker interrupting capacities. The short circuit rating for a panelboard without a current-limiting main circuit breaker shall not exceed the lowest interrupting capacity rating of any circuit breaker installed in the panelboard.

I. Provide thermal-magnetic circuit breakers that meet the requirements of UL 489 — *Molded Case Circuit Breakers*, NEMA AB 1 — *Molded Case Circuit Breakers and Molded Case Switches,* and Federal Specification W-C 375B/GEN — *Molded Case Circuit Breakers*.

1. Provide circuit breakers of the type, rating, and features as indicated on the Drawings.

2. Provide circuit breakers with the following minimum UL listed interrupting capacities:

a. 208Y/120V and 120/240V applications: 10,000 amperes, RMS symmetrical

3. Do not use tandem circuit breakers.

4. Provide multipole breakers with a common trip.

5. Provide bolt-on type circuit breakers or circuit breakers that connect to the panel bus through positive gripping connector jaws and are secured by an independent mechanical locking device.

J. Provide circuit breaker padlocking provisions for panelboard main circuit breaker and for all two-pole and three-pole circuit breakers.

2.2 LIGHTING AND APPLIANCE PANELBOARDS

A. Lighting and appliance branch circuit panelboard enclosures shall be not less than 20 inches nor more than 26 inches in width.

B. Manufacturers:

1. General Electric “Spectra” (480Y/277V) and “AQ” (208Y/120V or 120/240V).

2. Siemens “Sentron S3" (480Y/277V) and “Sentron S1" (208Y/120V or 120/240V).

3. Square D “I-LINE” (480Y/277V) and “NQOD” (208Y/120V or 120/240V).

4. Westinghouse ”Pow-R-Line 3" (480Y/277V) and “Pow-R-Line 1” (208Y/120V or 120/240V).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards following manufacturer’s written instructions, NEMA PB 1.1 — *General Instructions for Proper Installation and Maintenance of Panelboards Rated 600 Volts or Less*, and NFPA 70.

B. Install panelboards with top of panelboard trim 6'-2" (maximum) above finished floors.

C. Mount panelboards plumb and rigid without distortion of the box. Mount flush panels uniformly flush with wall surfaces.

D. Install filler plates in unused spaces in panelboards.

E. At flush panelboards stub four 1-inch empty conduits from panels into accessible ceiling space or space designated to be ceiling space in future. Stub four 1-inch empty conduits into raised floor space or below slabs other than slabs on grade.

F. Install an auxiliary gutter with permanently installed terminal blocks where a panel is tapped to a riser at an intermediate location.

G. Train conductors in panelboard gutters neatly in groups; bundle and wrap with cable ties after completion of load balancing.

H. Tighten electrical connectors and terminals, including grounding connections, according to the manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.2 IDENTIFICATION

A. Provide a typed circuit directory for each branch circuit panelboard. Revise directories to reflect circuiting changes required to balance phase loads.

B. Install electrical identification on panelboards and conductors according to Section 16195, Electrical Identification.

C. Mark floor in front of panelboards to show NFPA 70 required working clearances according to Section 16195, Electrical Identification.

3.3 CLEANING

Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.4 LOAD BALANCING

A. After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements and circuit changes as follows:

1. Do measurements during period of normal working loads as advised by the User.

2. Do load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Arrange with User to avoid disrupting critical 24-hour services such as FAX machines and on-line data processing, computing, transmitting, and receiving equipment.

3. Difference between any phase current and the average of the phase currents exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

4. Recheck loads after circuit changes during a normal load period. Record all load readings before and after changes and submit test records.

## 3.5 FIELD QUALITY CONTROL

A. Inspect installed panelboards for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

B. Upon completing installation of the system, perform the following tests:

1. Make insulation resistance tests of panelboard buses, components, and connecting supply, feeder, and control circuits.

2. Make continuity tests of circuits.

C. Refer to Section 16951, Electrical Acceptance Testing, for additional inspection, testing and calibration requirements.

END OF SECTION